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ABSTRACT

This teacher-training module examines the role of energy in changing cultural contexts. It is intended to assist the teacher in understanding the nature and uses of various conventional and nonconventional energy resources. Also examined are dimensions of energy policy making, implications of differing means of energy delivery in terms of technical efficiency, environmental impact, and social impact. (Author/RE)

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ENERGY RESOURCE DELIVERY AND USE

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SE 029 108

ENERGY RESOURCE DELIVERY AND USE

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ENERGY RESOURCE DELIVERY AND USE

THE THREE MAJOR SECTIONS OF THE MODULE

INQUIRY	INTEGRATION	APPLICATION
TEXT (SECTIONS 1-5) ACTIVITIES		THE PROBLEM CONTEXT GUIDELINES FOR DEVELOPING INSTRUCTIONAL MATERIALS
INQUIRY presents a knowledge base for understanding the uses of conventional and non-conventional energy resources. It also examines the dynamics of energy policy making.	INTEGRATION involves the teacher in analyzing and evaluating an energy policy plan.	APPLICATION presents a set of guidelines for planning and implementing instructional programs on the nature of Energy Resource Delivery and Use.

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During the past decade, there has been a growing public concern over the rapidly deteriorating state of our environment and the threat this deterioration poses for our ultimate survival. This environmental crisis involves a complex and interrelated set of problems which need to be addressed by both community leaders and individual citizens as they make public and personal decisions with respect to a variety of environmental problems. These problem areas include energy production and conservation, mineral and fossil fuel scarcities, food production, water allocation, urban, agricultural, and recreational land use, population dynamics, and pollution.

In order to adequately prepare citizens to meet the long-range planning and decision-making challenges which these environmental problems present, it is the goal of environmental education to develop their skills in: (1) analyzing environmental problems; (2) examining the pro and con arguments of a variety of public and private interest groups, labor, business, and government organizations; (3) exploring possible side effects of various environmental problem solutions; (4) predicting both short-term and long-term implications of local, state and national environmental programs; (5) articulating personal goals, desires, and lifestyle needs in terms of their aggregate (regional, national, or global) implications for energy use and resource allocation and (6) making long-term lifestyle decisions which are compatible with the requirements for maintaining an appropriate balance between natural system and human system functions.

Developing such capabilities can only occur through well-conceived and meaningful environmental education experiences. Curricula though geared toward people of different ages and societal levels, should have the following in common:

- Environmental education should be holistic and integrated... focusing on and clarifying the complex relationships which exist between natural systems and human systems and examining the components and reciprocal functions of both.
- Environmental education should be transdisciplinary... utilizing information from a variety of fields or disciplines (including the natural sciences, social sciences, and humanities) in order to deal adequately with the natural, social, aesthetic, and ethical dimensions of environmental problems which cut across and extend beyond disciplinary lines.
- Environmental education should be problem-focused and decision-making oriented...involving learners in real environmental problems or issues which are broad enough in scope to have regional, national, or global significance. It should engage learners in values clarification, problem-solving, planning, and decision-making processes which prepare them for dealing with environmental problems affecting both individual lifestyles and societal goals.

These characteristics are consistent with the Environmental Education Act of 1970 (as amended) which defines the requirements for informed, energy-literate, environmentally aware citizens. The Act designated the following as specific areas of concern: population dynamics, pollution, resource allocation and depletion, conservation, transportation, technology, urban and rural planning, environmental quality, and ecological balance.

In real life, these areas or "entities" occur in complex combinations. In fact, it is impossible to find a real life problem that concerns only one of these. For example, it is impossible to imagine a "transportation" problem that is not also concerned with "urban and rural planning" or "environmental quality."

In keeping with this Act, the four modules in this series of environmental education teacher training materials were designed to offer a holistic, transdisciplinary and problem-focused experience for teachers. The four modules are described below:

Optimal Use of Finite Land Resources

Teachers will use a carrying capacity methodology to examine finite land resources, population dynamics, and available energies that must be in dynamic equilibrium in order to maintain a stable balance between the needs of urban and agricultural systems as they develop and grow, and the needs of the natural system to maintain its ecological integrity.

Energy-Intensive Urban Growth and the Quality of Life

Teachers will examine the pattern of U.S. urban growth as influenced by economics and other considerations and compare these with considerations for enhancing the quality of life...will examine the potential of current urbanization to reverse its present trend toward high energy costs for urban society decreasing quality of life...will also examine the implications of envisioned future patterns of urbanization on energy costs and the quality of life.

Energy-Conserving Resource Utilization

Teachers will compare a variety of energy conservation strategies and their contributions toward a stewardship approach to resource utilization and conservation... they will analyze the conservation recommendations of the National Energy Plan and act as a Task Force Committee to propose conservation measures for a local community.

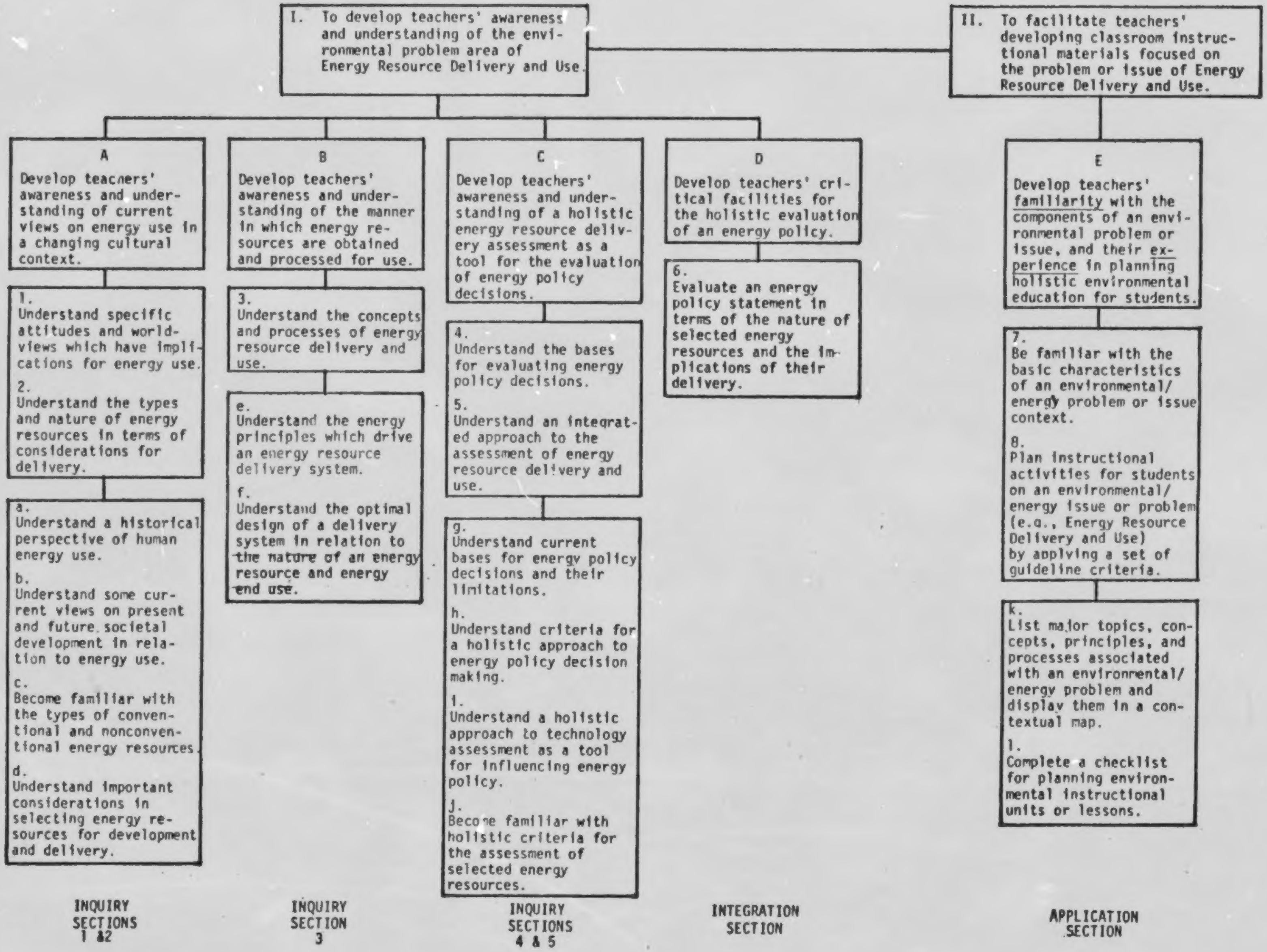
Energy Resource Delivery and Use

Teachers will examine the role of energy in changing cultural contexts...will study the nature and uses of various conventional and nonconventional energy resources...will examine the dimensions of energy policy making...will evaluate the implications of differing means of energy delivery in terms of technical efficiency, environmental impact, and societal implications...and will apply holistic criteria to the evaluation of an energy policy plan.

This field test version of Energy Resource Delivery and Use is based upon a secondary level environmental education model -- with an energy focus -- that was developed by the Far West Laboratory in 1977. This model provided us with a guideline and rationale for developing -- in this and the other three modules in the series -- a holistic understanding of our natural- and human-fashioned environment and for presenting this understanding in the context of environmental issues rather than as a simple presentation of subject matter. Integral to the four modules are the learning processes which allow us to explore the totality of interactions between the systems of humanity and nature and which promote our environmental awareness as citizens.

The contents of this module are restated and organized into goals and objectives which appear in the following chart. The top half of the chart (boxes I, II, and A - E) indicates the broad overall goals of the module and each of its major segments (INQUIRY, INTEGRATION, APPLICATION). The lower half of the chart (boxes 1 - 11, a - 1) indicates the specific teacher learning objectives for each section and each major activity of the module. These goals and objectives can serve as performance guides as you proceed through the materials. The chart reappears in its entirety at the beginning of the INQUIRY, INTEGRATION, and APPLICATION segments.

MODULE GOALS AND OBJECTIVES



I. To develop teachers' awareness and understanding of the environmental problem area of Energy Resource Delivery and Use.

A
Develop teachers' awareness and understanding of current views on energy use in a changing cultural context.

1.
Understand specific attitudes and world-views which have implications for energy use.

2.
Understand the types and nature of energy resources in terms of considerations for delivery.

a.
Understand a historical perspective of human energy use.

b.
Understand some current views on present and future societal development in relation to energy use.

c.
Become familiar with the types of conventional and nonconventional energy resources.

d.
Understand important considerations in selecting energy resources for development and delivery.

INQUIRY SECTIONS 1 &2

B
Develop teachers' awareness and understanding of the manner in which energy resources are obtained and processed for use.

3.
Understand the concepts and processes of energy resource delivery and use.

e.
Understand the energy principles which drive an energy resource delivery system.

f.
Understand the optimal design of a delivery system in relation to the nature of an energy resource and energy end use.

INQUIRY SECTION 3

C
Develop teachers' awareness and understanding of a holistic energy resource delivery assessment as a tool for the evaluation of energy policy decisions.

4.
Understand the bases for evaluating energy policy decisions.

5.
Understand an integrated approach to the assessment of energy resource delivery and use.

g.
Understand current bases for energy policy decisions and their limitations.

h.
Understand criteria for a holistic approach to energy policy decision making.

i.
Understand a holistic approach to technology assessment as a tool for influencing energy policy.

j.
Become familiar with holistic criteria for the assessment of selected energy resources.

INQUIRY SECTIONS 4 & 5

D
Develop teachers' critical facilities for the holistic evaluation of an energy policy.

6.
Evaluate an energy policy statement in terms of the nature of selected energy resources and the implications of their delivery.

INTEGRATION SECTION

II. To facilitate teachers' developing classroom instructional materials focused on the problem or issue of Energy Resource Delivery and Use.

E
Develop teachers' familiarity with the components of an environmental problem or issue, and their experience in planning holistic environmental education for students.

7.
Be familiar with the basic characteristics of an environmental/energy problem or issue context.

8.
Plan instructional activities for students on an environmental/energy issue or problem (e.g., Energy Resource Delivery and Use) by applying a set of guideline criteria.

k.
List major topics, concepts, principles, and processes associated with an environmental/energy problem and display them in a contextual map.

l.
Complete a checklist for planning environmental instructional units or lessons.

APPLICATION SECTION

ENERGY RESOURCE
DELIVERY AND USE

BASIC PREPARATION

This Teacher Training Module is designed to be used by a small group of teachers in a self-directed, team learning model. There is a need, however, for some initial preparations to be made in order to facilitate teachers' completing the module activities and acquiring the necessary knowledge and skills. These preparations include:

- Limit the number of teachers participating in the learning team to between 3-5; this number ensures the necessary level for team learning intensity, individual participation, and group cooperation.
- Select a suitable meeting place, free from distractions and outside interruptions, in which teacher learning activities can occur;
- Locate and assemble all required outside reading materials specified in the activities sections of the module;
- Reproduce these outside reading materials to prevent teachers from having to "wait around" for others to finish them;
- Arrange a suitable and mutually agreed upon schedule in which teachers can complete all readings, exercises, and activities specified in the module.

INQUIRY presents a knowledge base for understanding the uses of conventional and non-conventional energy resources. It also examines the dynamics of energy policy making.

INQUIRY

INQUIRY

The purpose of the INQUIRY is to present you with material and activities that will help you make informed decisions and formulate comprehensive curricula on aspects of Energy Resource Delivery and Use via a holistic approach. You will evaluate the interactions between natural and human systems which are an integral part of how we obtain and utilize energy resources, and consider the implications for the future of energy use.

More specifically, the INQUIRY orients you to the notion of a "Stewardship Worldview" by reviewing; various attitudes (and their implications) for energy delivery and use; the types of energy resources; concepts and processes of energy resource delivery and use.

After completing the INQUIRY, you will:

(A) Understand current views on energy use in a changing cultural context;

(B) Understand the manner in which energy resources are obtained and processed for use;

(C) Understand a holistic energy resource delivery assessment as a tool for the evaluation of energy policy decisions.

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This INQUIRY examines indicators for assessing energy resource delivery and use. Complete all INQUIRY activities (readings, discussions, exercises); work together to alleviate any difficulties encountered in these activities; "keep things moving" on schedule; and draw out each other's personal experiences where appropriate.

Specific things to keep in mind:

1. Estimated time to complete the INQUIRY is 35-40 hours.

2. Select a location or room for teacher learning activities which is reasonably quiet and free from distractions and intrusions (and from the possibility of disturbing or intruding on others). For example, avoid classrooms, teacher lounges/rooms or libraries during regular school hours. These same areas after school would probably be useful.

3. Resources needed will include access to a photocopy machine addtional paper, magic markers, crayons or pens (for the Cognitive Map exercise); also, cardboard boxes or styrofoam for 3-dimensional models (optional).

4. Plan a teacher training schedule that will accomodate the completion of all learning activities within the time specified in #1 above. Once teachers agree upon a workable schedule, adhere to it by trying to complete the activities for each section within the allocated time--each section requires about 5-6 hours. If it appears that for a given section of the INQUIRY you are going to run over the allocated time, you can:

   - Reschedule all subsequent section activities to accomodate completing the present section; or

   - Cut off the activity(ies) and move on to the next section.

5. Locate and collect the required reading and material resources specified in the module before the learning sessions begin. This will prevent you and the other teachers from having to spend your "learning" time doing so--unless, of course, the module specifically recommends such information gathering as a useful learning activity.

6. Make certain there are sufficient duplicate copies of the readings so no one is waiting for others to finish.

   Some suggestions for reducing the amount of reading time required are:

   - Make at least one copy of all required readings and have teachers share them; or
   - Make copies of more lengthy readings only and have teachers share these; or
   - Divide up the readings and have individual or pairs of teachers summarize these for the other team members; or
   - Any combination of the above which enables all teachers to complete the required readings in a reasonable amount of time.

7. All or most of the readings can be completed by teachers on their own time in order to free up the meeting times for group discussions and other team learning activities--it makes little sense to waste these occasions on reading sessions. Individual teachers can also take responsibility for leading discussions devoted to specific reading assignments or information gathering activities. Remember to select only the most salient points, concepts, principles or ideas from your readings to present to the group.

8. Some teachers may consistently want to do one type of reading (i.e., science oriented or values oriented). Encourage teachers to do a variety of readings. Try to keep all team members involved as active participants.

9. If members of the learning team are new to one another, you are encouraged to "break the ice" with each other by discussing what personal feelings, thoughts, or ideas you have about the notions of environmental education, ecology, or energy. Perhaps some teachers will have past experiences or anecdotes. This lightens up the beginning of the learning sessions, and gives your group the chance to get their values, beliefs, and attitudes into the open, to "see where everyone is coming from."

10. At the beginning of each section, have a brief overview discussion of what the section contains.

11. You are encouraged to discuss terms and concepts in order to reach a group consensus on their definitions and meanings before proceeding to the next section.

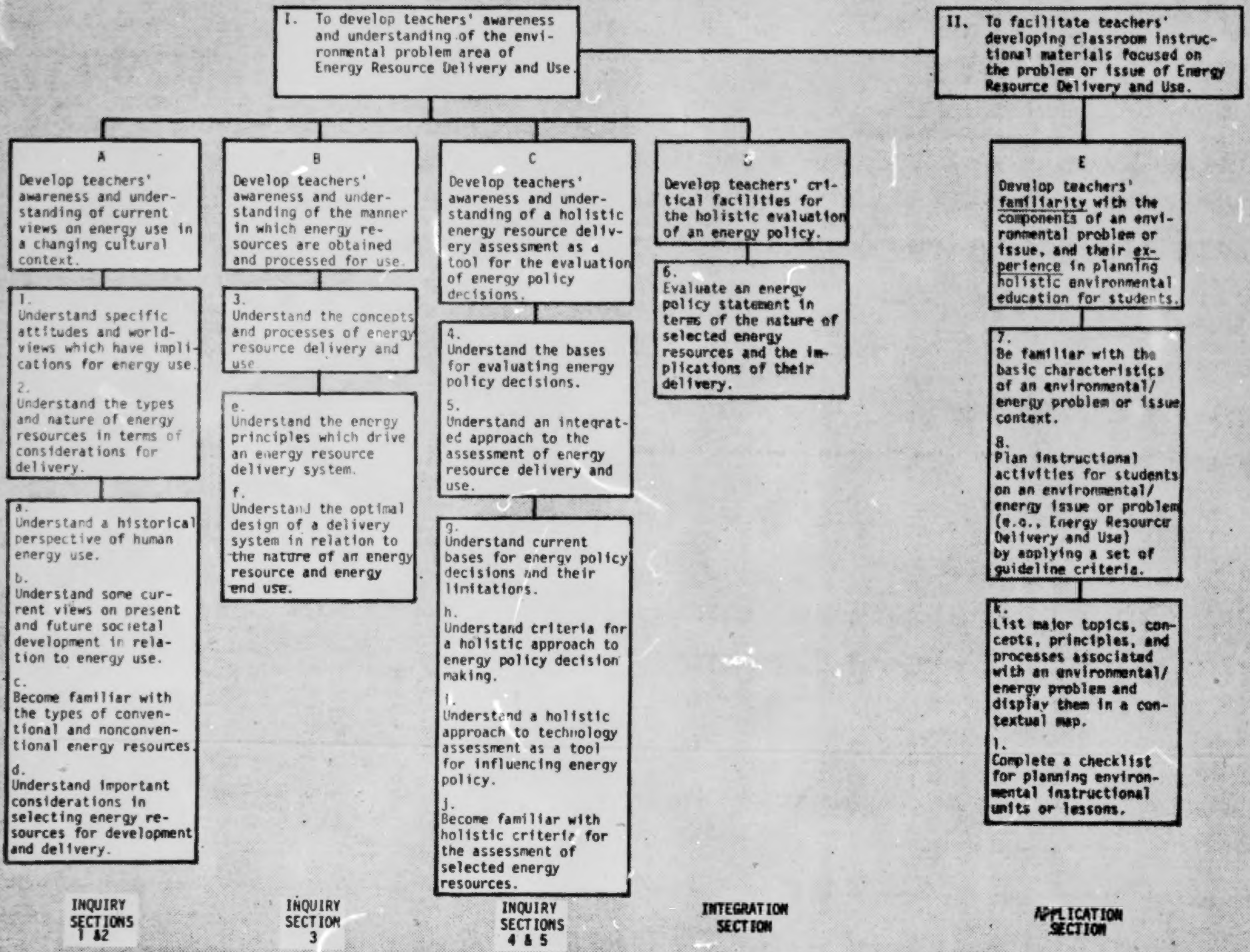
12. Some teachers may find it helpful to glance through the entire INQUIRY before beginning. For others this is not meaningful. But everyone should be familiar with the basic contents of the module (see Table of Contents and Section introductions) and the schedule for completing the sections.

13. Some of the exercises will give teachers ideas about creating materials for their students. This will be helpful in the APPLICATION, but should not be a focus of any discussion in the INQUIRY or INTEGRATION. You are encouraged to make notes for later use.

14. Answers to activity questions can be found in the Appendix, p. 257. Please do not look through these until each activity is completed.

The Module's Goals and Objectives Chart follows. Only those goals relevant to information presented in the INQUIRY are highlighted.

MODULE GOALS AND OBJECTIVES



I. To develop teachers' awareness and understanding of the environmental problem area of Energy Resource Delivery and Use.

II. To facilitate teachers' developing classroom instructional materials focused on the problem or issue of Energy Resource Delivery and Use.

A

Develop teachers' awareness and understanding of current views on energy use in a changing cultural context.

1. Understand specific attitudes and world-views which have implications for energy use.

2. Understand the types and nature of energy resources in terms of considerations for delivery.

a. Understand a historical perspective of human energy use.

b. Understand some current views on present and future societal development in relation to energy use.

c. Become familiar with the types of conventional and nonconventional energy resources.

d. Understand important considerations in selecting energy resources for development and delivery.

INQUIRY SECTIONS 1 &2

B

Develop teachers' awareness and understanding of the manner in which energy resources are obtained and processed for use.

3. Understand the concepts and processes of energy resource delivery and use

e. Understand the energy principles which drive an energy resource delivery system.

f. Understand the optimal design of a delivery system in relation to the nature of an energy resource and energy end use.

INQUIRY SECTION 3

C

Develop teachers' awareness and understanding of a holistic energy resource delivery assessment as a tool for the evaluation of energy policy decisions.

4. Understand the bases for evaluating energy policy decisions.

5. Understand an integrated approach to the assessment of energy resource delivery and use.

g. Understand current bases for energy policy decisions and their limitations.

h. Understand criteria for a holistic approach to energy policy decision making.

i. Understand a holistic approach to technology assessment as a tool for influencing energy policy.

j. Become familiar with holistic criteria for the assessment of selected energy resources.

INQUIRY SECTIONS 4 & 5

D

Develop teachers' critical facilities for the holistic evaluation of an energy policy.

6. Evaluate an energy policy statement in terms of the nature of selected energy resources and the implications of their delivery.

INTEGRATION SECTION

E

Develop teachers' familiarity with the components of an environmental problem or issue, and their experience in planning holistic environmental education for students.

7. Be familiar with the basic characteristics of an environmental/ energy problem or issue context.

8. Plan instructional activities for students on an environmental/ energy issue or problem (e.g., Energy Resource Delivery and Use) by applying a set of guideline criteria.

k. List major topics, concepts, principles, and processes associated with an environmental/ energy problem and display them in a contextual map.

l. Complete a checklist for planning environmental instructional units or lessons.

APPLICATION SECTION

There is growing public awareness of the impacts and implications that result from the use of different energy resources. This is evident in the increase of media coverage and legislative actions at local, state, and national levels. Examples of these differing energy strategies and issues include:[1]

- Coal Utilization
- Domestic Crude Oil Tax and Regulations
- Nuclear Development
- Natural Gas Pricing and Regulation
- Oil and Gas Consumption Taxes
- Utility Regulation
- Buildings Conservation
- Transportation
- "Appropriate" or Transition Technologies

Since the Industrial Revolution, the increase in energy consumption of this society has been responsible for drastic changes in the structures of economics, politics, and the environment. We have seen an increased public mandate for environmental impact statements for everything, from the effects of small local businesses to the national concerns formulated in the National Energy Plan. Yet most, if not all, of the information published on current energy policy fails to address the effects or disruptions that different energy strategies would have on all our patterns of societal organization. In other words, there is usually a lack of concern for a holistic comprehensive social assessment of the future development of energy technologies.

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[1] Adapted from Office of Technology Assessment (OTA), Analysis of the Proposed Energy Plan: August, 1977. Washington, D.C.: U.S. Government Printing Office.

To comprehensively address the task of increasing an informed public involvement in the creation of public energy policy, this teacher learning module is transdisciplinary, stressing the interactions between the systems of nature and humanity in relation to a specific environmental issue: ENERGY RESOURCE DELIVERY AND USE. It will present concepts and principles to be used as a knowledge base for understanding many issues of concern for energy policy decisionmakers. To do this, the material stresses a learner-directed exploration and encourages outside investigation of the issues.

An enormous range of viewpoints is currently being expressed in the debate over various energy delivery systems. This module exposes the learner to as many different characterizations of the issues as possible through appropriate readings and activities, as this is what he or she will encounter in the "real" world of energy policy decision-making.

The module also introduces the concepts and principles of holistic technology assessment as a framework for investigating energy delivery and use issues. This provides us with a set of comprehensive criteria for assessing and making recommendations about current and proposed energy strategies. The learner will be involved in group decision-making problems, where he or she applies these criteria to a simulated problem situation.

Because the issues of energy resource delivery and use are encountered daily outside the learning setting, this module stresses:

(1) a self-directed approach to discussion of the information; (2) the practice of planning and decision-making skills to assess energy strategies; and (3) the planning of energy resource delivery problem-focused learning activities for your students.

SECTION 1

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RESOURCES

Bender, Tom. Sharing Smaller Pies. Portland, Oregon: RAIN, 1975.

Elgin, Duane, et al. Alternative Futures for Environmental Policy Planning: 1975-2000. Standford Research Institute, Center for the Study of Social Policy. October, 1975.

Harman, Willis, "A Tentative Interpretation of the Present Decade," Appendix to Hearings Before the Subcommittee on Energy and Power, Part 2: Middle- and Long-term Energy Policies and Alternatives, Washington, D.C.: U.S. Government Printing Office, 1976.

Henderson, Hazel. Creating Alternative Futures. New York: Berkley Publishing Company, 1978.

Kahn, Herman, et al. The Next Two Hundred Years. New York: William Morrow and Co., Inc., 1976.

Lovins, Amory B. Soft Energy Paths. San Francisco: Friends of the Earth, 1977.

Scientific American. Energy and Power. San Francisco: W.H. Freeman and Co., 1971. Chapters 1, 5 and 6.

Steinhart, Carol and John. Energy: Sources, Use, and Role in Human Affairs. North Scituate, Mass: Duxbury Press, 1974.

SECTION 1

ENERGY AND CULTURAL DEVELOPMENT

After completing Section 1, you will:

(a) Understand a historical perspective of human energy use.

(b) Understand some current views on present and future societal development in relation to energy use.

In this section, we look at the role of energy in human affairs from a societal perspective. This viewpoint is important to an understanding of the resource requirements of contemporary and future social systems. It should help us see how human needs, values, and societal structures affect and are affected by our views of energy policy and practices. We are speaking here of views of energy use in a changing cultural context.

The history of humanity can be looked at in terms of energy--both the discovery of its principles and the invention of tools designed to improve working conditions. In industrialized cultures such as ours, this is particularly the case. Notable periods have been characterized by events considered to be bridges for obtaining extra energy for future development.

We have seen in this history of industrilization, the gradual transition from having a diversified resource base to one primarily focused on energy resources yielding high quantities of high quality energy. The growth which has occurred since the Industrial Revolution exemplifies this, representing a totality of changes in economic and social organization, and characterized by a particular worldview.* For some two hundred years, the industrial worldview dominated and shaped major goals, priorities, and social structures throughout the Westernized world. With this worldview, we have created many successes of technology and human ingenuity. However, we have also caused some "problems of success" which need to be addressed when examining current views on energy use.

This section, then, focuses on the importance of an emerging worldview in shaping perceptions about energy use and resource requirements.

---

*We will briefly define worldview as a set of beliefs about the basic nature of humanity, nature, and the universe: what we assume to be true and what we hope or think will become true. The concept of worldview will be expanded in the following discussions.

a. Energy and Human History

TOOLS

We have rarely been satisfied with simply using a tool for its original purpose. There has always been the notion of improvement for growth, the possibility of using a tool to invent something else or to make something else. When a culture reaches the point where it is no longer using its tools for survival, or the satisfaction of basic human needs, but, rather, is using tools to make tools, it quickly approaches a state of high entropy, where it takes excessive energy to satisfy the original goals.[1]

ENTROPY

ENERGY HISTORY

We can discern four major periods of human energy history, made distinct by the discovery of important energy principles or the invention of important energy tools. These periods are:

- hunting and gathering society in which the discovery of fire was made;
- agrarian society in which the technology of cultivation made possible the first permanent social groupings;
- advanced agrarian or pre-industrial society--the Middle Ages and the Renaissance--when the invention of modern harness and iron horseshoes increased horsepower; coal was introduced as a source of fuel; and metallurgy provided a new dimension to technology and the complexity of social structure. Steinhart indicates the importance of the rise of capitalism at this time in history:

---

[1] Entropy describes the process that causes available energy to continuously degrade in quality (or the amount of work available from it).

> "It is interesting to ponder whether the goals and abstractions of capitalism were more real as a guide for life than the saints, angels and demons that cast their shadows on the medieval world. Capitalism was the ultimate alchemy. It transmuted everything into gold."[2]

- industrial society--when the industrial revolution became the new ruler of America, offering abundant opportunities in agriculture and transportation, and challenges to increased expansion of energy-producing techniques.

On the following page is a timeline of some of the major events in the history of humanity and energy.[3] We have listed some reading material at the end of this section to help you in filling out this timeline with knowledge of how discoveries and inventions affected and were affected by the social structure and values of the times.

---

[2] Steinhart, Carol and Steinhart, John. Energy: Sources, Use and Role in Human Affairs. North Scituate, Mass: Duxbury Press, 1974. p. 40 (emphasis ours)

[3] Adapted from Steinhart, appendix C, pp. 329-331, "Chronology of the Events in the History of Man and Energy".

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1,700,000 B.C.	First Ice Age begins. Several varieties of erect, man-like primates exist.
Before 500,000	Man begins to use fire.
Before 13,000	Domestication of the dog.
9,000	Beginnings of agriculture.
8,000	Last retreat of the continental ice sheet.
7,000	First sickles, found in Palestine.
6,000	Domestication of goats, pigs, sheep, cattle, oxen.
4,000	Domestication of the horse.
3,500	Wheel invented, probably in Mesopotamia.
3,000	Man learns to smelt metal and make bronze.
1,000	Beginning of iron technology. Domestication of the camel.
300	Waterwheels in Greece
200	Modern harness invented in China.
100	Horizontal shaft waterwheel produces 0.3 kilowatts power.
27	Book by Vitruvius describes watermills, steam jets, and machines in general.
A.D. 300	Vertical shaft waterwheel produces 2 kilowatts power.
500	Waterwheels come to Europe.
650	First Windmills. Modern horse harness reinvented in Europe.
852	Coal burned in an English monastery.
900	Whale oil used for lighting.
1239	Coal used as fuel by smiths and brewers.
1300	First coal used in home heating.
1404	First giant cannon, in Austria.
1500	Tide mills in the Netherlands; windmills used to drain submerged lands and maintain them.
1600	Versailles water works produces 56 kilowatts power.
1606	First known experimental steam engine built by Della Porta.
1673	Huygens builds internal combustion engine run on gunpowder.
1690	Papin designs the first piston engine.
1693	Leibnitz states the law of conservation of potential and kinetic energy.
1712	Newcomen builds first steam pumping engine.
1740	Improvements in iron technology.
1765	Modern steam engine conceived by Watt.
1789	Coulomb's work in electrostatics.
1820-1860	Work of Oersted, Ampere, Faraday, and Maxwell in electricity. Principles of thermodynamics worked out by Carnot and Clausius.
1857	First oil well drilled in Pennsylvania.
1866	Transatlantic cable laid.
1876	Otto designs four stroke internal combustion engine.
1882	First incandescent lighting, New York.
1895	Roentgen discovers X-rays.
1896	Becquerel discovers radioactivity.
1898	Tsiolkovski works out principles of rocket flight.
1903	First flight of Wright brothers.
1920	First scheduled public radio broadcast, Pittsburgh.
1926	Coddard fires first rockets with liquid propellant.
1941	First jet plane flight.
1942	Fermi starts first atomic reactor in Chicago.
1945	Uranium bomb dropped on Hiroshima; plutonium bomb, on Nagasaki.
1952	First hydrogen bomb explosion.
1954	Launching of first atomic-powered submarine, Nautilus. First nuclear power plant put into service near Moscow, U.S.S.R.
1957	Sputnik I, first artificial satellite. First nuclear power plant in U.S., Shippingport, Pennsylvania.
1969	Man lands on the moon.
1969	National Environmental Policy Act enacted.
1970	Domestic oil production peaks at just over 10 million barrels per day.
1973	Arab oil embargo: the nation gets exposed to the "energy crisis".
1974	Solar Heating and Cooling Demonstration Act.
1975	Energy Research and Development Administration established.
1977	Trans-Alaska pipeline opened.
1978	U.S. Department of Energy established.

Figure 1

TIMELINE: Major Events In The History of Humanity and Energy

b. Problems of Success

Since the Industrial Revolution, we have seen many successes of technology and innovation. However, we have also begun to witness some major problems that stem from these same technological successes. Below is a brief list of some successes of recent times and the "problems of success" associated with each.* Most of these "problems of success" obviously overlap and are intricately interconnected.

- prolonging life span: regional overpopulation; increased problems of senior citizens.
- highly developed science and technology: increased risks of nuclear and biological sciences used for warfare.
- machine replacement of manual and routine labor: increased, selected unemployment; urbanization.
- advances in communication and transportation: increasing noise, air, land, and water pollution; information overload.
- efficient production systems: capital- and energy-intensive production, with less human involvement.
- affluence: increased per capita consumption of energy and materials, leading to depletion of sources and pollution.
- satisfaction of basic needs: rising expectations, movements against nonmeaningful work.
- expanded power of human choice: unanticipated consequences of technological applications, such as sabotage and warfare.

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*Adapted from Harman, Willis, "A Tentative Interpretation of the Present Decade," Appendix to Hearings Before the Subcommittee on Energy and Power Part 2: Middle- and Long-term Energy Policies and Alternatives, Washington, D.C.: U.S. Government Printing Office, 1976, p. 17.

c. Worldview Parameters

A worldview is a set of beliefs concerning the basic nature of man and the universe. The key word in this definition is belief. Beliefs, unlike facts, are neither verifiable nor demonstrable. They are based on certain assumptions and hopes: what we assume to be true and what we hope will become true.

This set of beliefs is a part of the process of forming values. It influences in direct and subtle ways how we perceive and judge our experiences. Our worldview plays a major role in molding our attitudes, shaping our behavior and forming our values.

Worldviews, though largely invisible, nonetheless play important roles in our choice of policies, the kinds of educational systems we design, our approach to resource utilization and distribution of material goods, our priorities with respect to human needs, and so on.

Any worldview can be examined (in terms of its viewpoints or perspectives) by using a set of broad parameters[4] or guidelines which are helpful here in considering the relationship of current and future energy policy.

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[4] Adapted from Elgin, Duane, et al. Alternative Futures for Environmental Policy Planning: 1975-2000. Stanford Research Institute, Center for the Study of Social Policy. October, 1975, pp. 182-183.

WORLDVIEW PARAMETERS

The following parameters define the scope of a worldview:

- an image of the world
- technology and capital
- management and decision-making
- energy resources
- current growth patterns
- innovation and discovery
- income and poverty
- industrial development
- quality of life, present and future
- long-range outlook, a "futures scenario"

The following chart characterizes two opposing worldviews in terms of those parameters which have a direct bearing on energy use.[5] Both are currently held by wide segments of the population; both have certain beliefs about the future state of industrialized culture.

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[5] Adapted from Kahn, Herman, et al. The Next Two Hundred Years. New York: William Morrow and Company, Inc., 1976, and Elgin, Alternative Futures for Environmental Policy Planning, pp. 182-183.

	WORLDVIEW #1	WORLDVIEW #2
BASIC WORLD MODEL	*Unlimited pie.* The important resources are capital, technology and educated people. The greater these resources, the greater the potential for even more. There is no persuasive evidence that any meaningful limits to growth are in sight--or are desirable. If any very lon-term limits set by a "finite earth" really exist, they can be offset by the vast extra-terrestrial resources and areas that will become available soon. Man has always risen to the occasion and will do so in the future despite dire predictions from the perennial doomsayers who have always been scandalously wrong.	*Finite pie.* We have a fairly good idea of what the world can provide. Current estimates show we will be running out of many critical resources in the next 50 years. Since there is only so much "pie", it should be distributed more evenly. Because the pie shrinks over time, any economic growth that makes the rich richer will only make the poor poorer, unless we share fairly.
TECHNOLOGY AND CAPITAL	*Solves almost all problems.* Some current problems have resulted from careless application of technology and investment, but none without a remedy. It is not paradoxical that technology which caused problems can also solve them--it only requires mankind's attention and desire. There is little doubt that sufficient land and resources exist for continual progress on earth. Most current problems are the result of too little technology and capital, not too much. In any case man's desire for expansion into new frontiers will lead eventually to the colonization of the solar system and effectively unlimited world-view.	*Diminishing returns.* Proposed technology and additional capital investment, necessary to extract marginal resources, are shortsighted illusions that will only increase pollution and accelerate the exhaustion of resources. In any case, we shall have to cope with diminishing marginal returns and utilities, facing more situations in which the energy required for the returns gained increases dramatically.
ENERGY RESOURCES	*Economics and technology can provide supurb solutions.* The earth is essentially bountiful in all of the important resources. Sudden large price fluctuations tend to be "self-correcting" within a few years although they can be misinterpreted as basic shortages (as in 1973-74). Near-term prices are certainly important, but we have often lived with short-term problems. Trust in the economics of the market system, confidence in emerging technological solutions and a little patience will remedy the current resource issues just as they have in the past.	*Rapid and steady depletion.* Humanity is rapidly depleting the earth's potential resources for food, energy and minerals, and overshelming its capability to absorb or recycle pollutants. Many key resources will soon be seriously depleted. While most of these problems will not show catastrophic results until the 21st century, food, energy, and mineral shortages and environmental pollution are already critical problems. All signs point to disastrous events in the medium and long-term future.
FUTURES SCENARIO	*High optimism and confidence.* We cannot know mankind's ultimate goals, but they include a solar civilization and a utopian notion for the quality of life on earth. The potentialities of modern technology and economic progress are just beginning to be visualized. Dangers exist, but they always have and always will. There is no need for faint heart. Man should face the future boldly and openly because the future is his to determine--and to enjoy.	*Bleak and desparate.* Unless revolutionary changes are soon made, the 21st century will see the greatest catastrophe since the Black Death. Large-scale damage is a plague to the environment and to the ecology of many areas. Billions will have to be held down by harsh authoritarian governments. Grave draconian measures are justified now to alleviate the extent and intensity of the future collapse.

d. An Emergent Worldview

From the examination of various current beliefs such as those contrasted in the previous subsection, and from further examination of important world issues, observers have recently begun to state their notions about major inconsistencies between belief and fact. These inconsistencies, when compared with observed facts, seem to contradict some of the key assumptions of the industrial worldview. In fact, it seems that the knowledge and technology which developed because of the emphasis on growth and production in the last two centuries can be used to examine this prevalent worldview.

POST-
INDUSTRIAL
AGE

Many of the observers and analysts of societal and cultural developments interpret this present period of rapid change as constituting a major break with past standards, perceptions and assumptions about the nature of the world and humanity. In other words, we are undergoing a shift in worldview. These observers are calling this period the beginning of the post-industrial age. Harman states that, after he examined various future perspectives,

> "The only practical paths that lead to a generally desirable future seemed to require a monumental task of social learning and a major transformation of social institutions to be substantially accomplished in the period before the mid-1980's."[6]

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[6] Harman, Willis, "Tentative Interpretation of the Present Decade", Appendix to Hearings Before the Subcommittee on Energy and Power, Part 2: Middle- and Long-term Energy Policies and Alternatives, Washington D.C.: U.S. Government Printing Office, 1976, p. 17.

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As such, a change of this magnitude will have a fundamental effect on social, political, economic and technological interrelationships, and will have direct implications for energy policy and practices.

The validity of projections and forecasted futures is, of course, uncertain until events actually occur. But we can observe current changes and project possible or probable future scenarios on the basis of what we see. Accordingly, a focal point in today's evolving worldview is the effects of our attitudes and beliefs on both the human and natural systems. Certain of our assumptions about growth, technology, natural resources and the quality of life have been challenged or proven wrong.

> We have plunged headlong for more that half a century into development of a technological direction unprecedented on this planet, and are now finding that its direction is unsustainable, its effects undesirable, and its replacement necessary if we are to ensure the soundness, stability, and permanence of our society, our individual freedom and opportunity for personal growth, and the overall health and well-being of our society.[7]

The worldview that is currently evolving will have to accomodate new values and new concerns if it is to enhance our quality of life while maintaining a harmonious relationship with the biophysical systems that support our existence.

This new worldview, which we call a Stewardship Worldview, recognizes the need to re-evaluate our present visions and the unrealistic demands we make on our energy resources and life support systems to fulfill these visions.

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[7] Bender, Tom. Sharing Smaller Pies. Portland, Oregon: RAIN, 1975, p. 5.

These are some particularly important recent developments that will have an effect on the emerging stewardship-focused transformation of values and beliefs. These include:[8]

(1) "Spaceship earth" thinking; awareness of the biosphere as a life-support system; concern for environment, ecological systems, resource control;

(2) "Alternative futures" thinking; awareness of the power of technological manipulation to shape the future, and of the new dimensions of human responsibility for the future of the planet and for its life forms;

(3) Shift from problems in manipulating the natural environment to problems of technological success:

(4) Shift of human need concerns throughout the industrialized world, from materialistic and status values toward humanistic and spiritual values;

(5) Awareness, throughout the lesser developed world and poorer groups, brought about in part by modern communication and transportation, of major inequities in access to the earth's resources and of the power to change this;

(6) Beginning of a shortage of meaningful social roles brought about by automation and cybernation;

(7) Emergence of widespread interest in religions and spiritual concerns, psychic phenomena, metaphysical philosophies, meditation and other"consciousness techniques", and the possibilities of extraterrestrial intelligence.

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[8] Adapted from Harman, "A Tentative Interpretation of the Present Decade", pp. 18-19.

ACTIVITIES

FACILITATING NOTES

Activity I:

1. You may wish to xerox multiple copies of this reading, if necessary.
2. Answers to these questions can be found on p.17.

Activity II:

1. You may wish to xerox multiple copies of the reading for each subgroup.
2. The discussion about worldviews and energy use may develop into an interesting exchange between the views represented by the readings and the teachers' own views. Teachers should be encouraged to draw on their own experiences as much as possible. The discussion does not have to be lengthy, as later on in the module points of view such as these will surface again.
3. If your group has time, it would be valuable for all teachers to complete all the readings, to gain a better understanding of each author's point of view.
4. Sample answers and suggestions for discussion can be found on p. 26.

OBJECTIVE: (a) Understand a historical perspective of human energy use.

READINGS: Steinhart, Carol and Steinhart, John. Energy: Sources, Use and Role in Human Affairs. North Scituate, Mass.: Duxbury Press, 1974. Chapter 4, pp. 33-47.

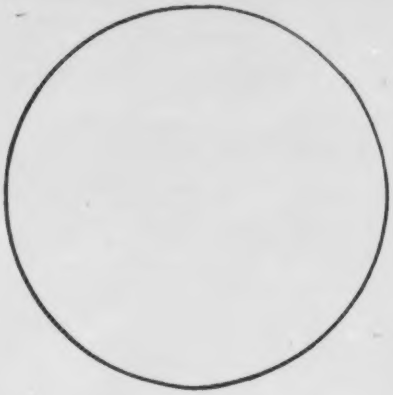
Scientific American, Energy and Power. San Francisco: W.H. Freeman and Co., 1971. Chapter 1, Chauncey Starr, "Energy and Power," pp. 3-8; Chart "Flow of Energy Through the U.S., 1970," pp. 86-87.

TO DO: Complete the reading, review the module text, and complete the following questions.

1. List the first four periods of energy history. List the major fuels of these periods.
2. What was the breakdown of energy consumption in the U.S. in 1850 by fuels? Indicate these relationships by breaking up the energy "pie" below.

3. In the last half of the 19th century, what were some of the major factors leading to the industrial development of America?

4. What was the breakdown of energy consumption in the U.S. in 1970?
   Indicate these relationships by breaking up the energy "pie" below by fuels:



U.S. ENERGY
CONSUMPTION
1970

OBJECTIVE: (b) Understand some current views on present and future societal development in relation to energy use.

READINGS: Bender, Tom. Sharing Smaller Pies. Portland, Oregon: RAIN, February, 1975. pp. 1-20.

Henderson, Hazel. Creating Alternative Futures. New York: Berkley Publishing Corporation, 1978. Chapter 1, pp. 11-33.

Lovins, Amory B. Soft Energy Paths. San Francisco: Friends of the Earth, 1977. pp. 12-14.

TO DO:

1. Review the module text.
2. Divide up into three groups, so that each group completes one reading and one segment of the first part of this activity.
3. Complete the following Worldview Characterizations Chart #1 for each reading, as indicated. (p. 32)
4. Compare these characterizations by completing the Summary Chart #2 as a group activity. (p. 33)
5. Discuss the Summary Chart in terms of similarities and/or differences in the approaches of these authors to stewardship values.
6. Discuss the relationship of stewardship values to energy use. Do you agree or disagree with these author's viewpoints in relation to past and future energy use? Discuss your reasons.

DIRECTIONS: WORLDVIEW CHARACTERIZATIONS CHART #1

- Each teacher or group of teachers will fill out the second column in relation to the particular reading done.
- Provide a statement from the reading which seems to best exemplify the particular author's characterization of each stewardship value in the left-hand column. Indicate the page number(s). (Refer to p. 26 in the text for complete statements about each value.) NOTE: All authors may not speak to every stewardship value.

READING: ______________________________
(Title) (Author)

STEWARDSHIP WORLDVIEW VALUE	EXEMPLARY STATEMENTS
(1) "Spaceship earth" thinking	
(2) "Alternative futures" thinking	
(3) "Problems of success"	
(4) Humanistic and spiritual values	
(5) Awareness of inequities	
(6) Social roles and automation	
(7) Increased interest in spiritual concerns	

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DIRECTIONS: Fill in major points from all authors' exemplary statements in Chart #1.

WORLDVIEW CHARACTERIZATIONS SUMMARY CHART #2

STEWARDSHIP WORLDVIEW VALUE	READING #1:	READING #2:	READING #3:
(1) "Spaceship earth" thinking			
(2) "Alternative futures" thinking			
(3) "Problems of success"			
(4) Humanistic and spiritual values			
(5) Awareness of inequities			
(6) Social roles and automation			
(7) Spiritual concerns			

SECTION 2

RESOURCES

Clark, Wilson. *Energy for Survival*. New York: Anchor Press, 1974.

Ehrlich, Paul; Ehrlich, Anne, and Holdren, John. *Ecoscience*. San Francisco: W.H. Freeman and Co., 1977.

Executive Office of the President, Energy Policy and Planning, *The National Energy Plan*. Washington, D.C.: U.S. Government Printing Office, April 29, 1977.

Lovins, Amory B. "Energy Strategy: The Road Not Taken?" *Foreign Affairs*, Vol. 55, No. 1, October, 1976.

Miller, G. Tyler. *Living in the Environment*. Belmont: Wadsworth Publishing Co., 1975.

Steinhart, Carol and Steinhart, John. *Energy: Sources, Use, and Role in Human Affairs*. North Scituate, Mass: Duxbury Press, 1974.

Tuve, George. *Energy, Environment, Populations, and Food*. New York: Wiley-Interscience Publications, 1976.

SECTION 2

THE NATURE AND TYPES OF ENERGY RESOURCES

After completing Section 2, you will:

(c) Become familiar with the types of conventional and nonconventional energy resources.

(d) Understand important considerations in selecting energy resources for development and delivery.

Most of the energy demand in the U.S. is supplied by petroleum and natural gas. However, there are a number of other resources currently supplying this demand. Also, a further number of alternatives are being explored as means to optimize the quality of our energy future. This section introduces you to the types and nature of various conventional and nonconventional energy resources.

ENERGY RESOURCES

Most systems, both natural and human, are built and maintained by a combination of natural and developed energy resources. (Energy, in this context, includes not only natural and humanly developed sources, but also materials, goods, and services which also contain forms of energy.) When energy resources are plentiful, most systems increase their assets and growth; when energy resources are in short supply, activities decline and the systems then use available energy for maintenance rather than growth or construction.

To help you track an individual energy resource through its delivery process, we present a brief introduction to the various types of resources. As an integral part of any assessment of energy delivery and its use, it is necessary to understand the nature of the resources and their current and possible uses. The development of most energy resources often involves difficulties in extraction or collection, or significant environmental costs to natural or human systems either during or after obtaining them.

a. Distinctions between Energy Resources

Some resources exist in a natural state and some are by-products of other activities in our society.

We can define two categories of energy resources:

NON-RENEWABLE RESOURCES

- Non-renewable: The use of these resources is dependent on the amount of supply in existence. These finite reserves are made available to society as a function of available technology and capital investment.[1]

RENEWABLE RESOURCES

- Renewable: The use of these resources is determined by their rate of renewal. These infinite reserves are available at specific rates to humanity depending upon specific locale; their availability as an energy resource is also a function of available technology and capital investment.

The following chart lists these renewable and non-renewable energy resources:

NON-RENEWABLE ENERGY RESOURCES	RENEWABLE ENERGY RESOURCES
Fossil fuels	Solar energy
petroleum	Fresh water
natural gas	Wind power
coal	Oceanographic
oil shale	tidal power
tar sands	thermal gradient
Nuclear energy	Geothermal energy
fissionable materials	steam
fusionable materials	heat
	Biomass
	Life forms
	human work
	photosynthesis

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[1] Lovins, Amory, "Energy Strategy: The Road Not Taken?" Foreign Affairs, Vol. 55, No. 1, October, 1976, pp. 65-96.

The most important distinctions between these types of resources are summarized below.

NON-RENEWABLE RESOURCES	RENEWABLE RESOURCES
• exist in the earth in limited quantities that could conceivably be used up	• will be available so long as the earth ecosystem continues to function
• comprise forms of high quality energy that have been historically easier to collect and use	• tend to be of higher entropy and require more effort and energy input for collection and use
• constraints on availability arise from the necessary energy required to pump or dig them up	• available for use as fast as they are supplied by the natural system--for example, more wind or sunlight cannot be collected than passes through an area during a day

PRIMARY RESOURCES

SECONDARY, TERTIARY RESOURCES

The above resources are often referred to as primary energy resources, because they drive the production and delivery of energy. Secondary or tertiary energy resources are energies recycled from processes driven by either a renewable or non-renewable type of primary resource. For example, the steam usually discarded as waste heat from a power plant can be re-used. It is not hot enough to drive the turbines; however, it is hot enough to heat the surrounding buildings.

COGENERATION

This is an example of a cogeneration system. These systems improve the overall energy efficiency of an energy delivery system by recycling energies that would otherwise have been lost to waste.

b. Types of Energy Resources

CONVENTIONAL ENERGY RESOURCES

NON-CONVENTIONAL ENERGY RESOURCES

Those energy resources which currently yield most of our energy supply are here referred to as "conventional" energy resources. Other resources, either contributing on a small scale or being explored as to availability and potential large-scale contribution are termed "non-conventional" resources.* Following is a discussion about the nature of these energy resources. The first five are considered "conventional." The latter (#6 - 14) are considered "non-conventional." The resources discussed here are:

"Conventional" energy resources:

(1) Petroleum
(2) Natural gas
(3) Coal
(4) Hydroelectric power
(5) Nuclear energy

"Non-conventional" energy resources:

(6) Synthetic fuels
(7) Oil shale and tar sands
(8) Solar energy
(9) Hydrogen fuel
(10) Wind power
(11) Tidal power
(12) Geothermal energy
(13) Biomass
(14) Miscellaneous energy converters

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*Executive Office of the President, Energy Policy and Planning, The National Energy Plan. Washington, D.C.: U.S. Government Printing Office, April 29, 1977, p. xiii.

(1) Petroleum

Oil production is largely the process of tapping deep trapped pools of oil by drilling to greater and greater depths. The earliest wells were only 21 feet but modern oil wells sink to a depth of 5 miles or more.* Today, teams of earth scientists use extensive technologies for geologic, seismic, magnetic, gravitational, and electrical exploration in the search for oil deposits. This includes exploration into the bottom of the sea, the deserts, and subpolar regions.

PROVED
RESERVES

"Proved reserves" of oil (or of any depletable resource) are the amounts proved by exploration to exist, and known to be recoverable by methods which are both technically and economically feasible. The rate of oil exploration is currently geared to the rate of production, for economic reasons. However, it is wise not to forget that the amount of an exhaustible resource that is ultimately produced cannot exceed the amount that is originally present, and every bit that is withdrawn can only decrease the amount that remains.

Of the world's known petroleum reserves, the U.S. is estimated to have about 5 or 6%.[2] However, we are accustomed to consuming nearly one-third of the world's annual supply.[3] This oil supply gives us "automobility" and jet plane freedom, in air-conditioned comfort. The transportation furnished by trains, trucks, ships and boats, campers and motorcycles is all dependent upon the oil-burner. Construction equipment and maintenance equipment, as well, are added to this list. In parts of the U.S., most of the fuel for winter heating and electric power generation is oil. And how often do we consider that much of the clothing, carpeting, matresses, and furnishings we use are made of fibers and other materials for which oil is the basic raw material?

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*Steinhart and Steinhart, p. 95.

[2] Tuve, George L. Energy, Environment, Populations, and Food. New York: Wiley Interscience Publications, 1976, pp 53-54.

[3] Ibid.

Some of the results of our dependence on petroleum as a major fuel source are obvious, such as oil spills, the high prices of gasoline, and traffic jams. Other types of environmental costs are not so immediately visible. The exploration process causes transient and negligible damage in and of itself. At offshore production sites blowouts and spillage accidents account for less than 5 percent of the oil which pollutes the seas.* Since oil spilled in the Arctic region does not decompose as readily as oil spilled in warmer climate zones, these types of accidents are potentially more damaging.

The most important environmental effect regarding oil production is the long-range problem of increased storage, refining, and transportation. For example, on the Atlantic seaboard it is not so much the sight of off-shore platforms that is so alarming, but the increased tanker traffic and pollution originating from refineries.

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*Steinhart and Steinhart, p. 116.

(2) Natural Gas

NATURAL
GAS
LIQUIDS

The natural gas of commercial use is methane, a member of the paraffin series of hydrocarbons. Various other paraffins are also extracted as byproducts of natural gas production. These are known as natural gas liquids. One example of these compounds, liquified petroleum gas, is a mixture of primarily propane and butane, and is bottled for cooking and heating.

Natural gas was a nuisance to early oil producers. They usually allowed it to escape into the air or burned it on site. In the late 1920's, the development of such technologies as high-pressure pipe, improved welding, and power equipment for laying pipe made transporting gas a reasonable economic venture. Also, because gas and oil often occur together, the gas industry found that its production increased automatically as oil production increased. As a result of massive supply and little demand, the price of gas remained very low initially, and it is still kept at a low level by federal regulation. Due to this low cost level, the market for natural gas has gradually increased.

As natural gas became more widely used, its advantages became more apparent. It is the most convenient fuel for non-transport uses. It requires no storage tanks, but can be directly piped to the use site. It is basically a clean fuel, and can be burned in simple, inexpensive furnaces. It requires no antipollution devices. In many locations, it became cheaper than oil or coal. The environmental costs of natural gas production are mainly those associated with extraction, as gas is usually a byproduct of oil extraction.

The peak of production for natural gas is expected to be somewhere around 1980.[4] Some predictions estimate the exhaustion of reserves in the contiguous U.S. (not including Alaska and Hawaii) by 1990. The peak of discovery has already passed, as new discoveries are not keeping up with the growing market.

Some developments which can decrease the wasteful use of natural gas include:

- a decrease in the flaring of gas at it source;
- an increase in electrical power-generating facilities and gas-consuming industries near the production sites;
- building of pipelines;
- the construction of special tankers for the transport of liquid natural gas.

Natural gas or its equivalent could become available from the following methods which are already in experimental use:

- gas from coal (see p. 55)
- gas from other hydrocarbons and from organic wastes (see p. 67)
- hydrogen from electrolysis of water (electrical separation of water into hydrogen and oxygen (see p. 62)

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[4] Steinhart and Steinhart, p. 101.

(3) Coal

Except for its role in the iron and steel industry, the use of coal presently is almost completely in electricity systems. Recently, however, air and water quality standards have led many power companies to use oil, gas, or nuclear fuel for their newer installations. This is due largely to shortages of low-sulfur coal for firing into electrical generation systems.

COAL RESERVES

It is easier to judge the extent of coal reserves than to gauge hidden petroleum deposits. Coal is usually found close to the surface. Deposits are stratified and continuous over large areas and are often visible as outcroppings above ground. In the first thousand years of coal mining, less than 10 percent of the world's estimated coal reserves have been taken from the ground.[5] In the United States, proposals for increasing the mining of coal are being considered, as coal can be used to produce natural gas, as well as to generate electricity.

STRIP MINING

Most of this projected increase in mining will affect those deposits at the surface and will involve surface or strip mining. Most of this activity would occur in Montana, Wyoming, and North Dakota, where about one-third of the most accessible deposits are found.[6] There are many arguments both pro and con to these proposed mines and gas conversion facilities. These include considerations of the energy's quality, pollution resulting from mining and processing, the removal of solid waste, and the large water requirement.

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[5] Ibid.

In one hour's operation, a typical coal-fired electric power plant produces (from 300,000 kilograms or 340 tons of coal) the following pollutants:*

- 850,000 kilograms (940 tons) of carbon dioxide, which is significant in reducing the amount of sunlight that reaches the earth;
- 12,000 kilograms (13 tons) of carbon monoxide, which in concentration can cause suffocation to animals and humans;
- 15,000 kilograms (17 tons) of sulfur dioxides, for which there is no satisfactory method for removal after burning and which convert to sulfuric acid, precipitating to the ground in so called "acid-rains," which have been linked to asthma, bronchitis, emphysema, and lung cancer.**
- 3,400 kilograms (3.4 tons) of nitrogen oxides, which participate in a series of photochemical reactions that lead to smog, cumulative respiratory damage, and possibly further eutrophication or stagnation of lakes near urban areas; and,
- 31,000 kilograms (34 tons) of ash, of which particles act as nuclei for local fog.

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[6] Tuve, Energy, Environment, Populations, and Food, p. 59.

*Steinhart and Steinhart, p. 123.

**Ehrlich, Paul; Ehrlich, Anne, and Holdren, John. Ecoscience. San Francisco: W.H. Freeman and Co., 1977.

G 1

(4) Hydroelectric Power

The energy from falling water, kinetic energy, although essentially derived from solar energy,[7] is formed from the accumulated energy of all the water that falls as precipitation and flows to the seas. Whether or not we use it, it is constantly released. In the U.S., hydroelectric power furnishes less than 4% of our total energy supply and about 15% of our electricity. [8,9]

DAMS

In order to produce hydroelectric power, a dam must be built on a river, using turbines and generators at the base of the falls. The reservoir behind the dam stores kinetic energy that would otherwise have been lost falling to the river on the next levels. When tunnels through the dam are open, water pours through and spins turbines which drive the generators to produce electricity.

The hydroelectric plants are usually part of larger developments which can involve navigation, recreation, fish and wildlife management, water quality control, water supply, flood control, or irrigation. Unless the power must be transported over long distances, this combination of uses generally makes hydroelectricity one of the most economical power sources.

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[7] Steinhart and Steinhart, p. 167.

[8] Tuve, Energy, Environment, Populations, and Food, p. 61.

[9] Steinhart and Steinhart, p. 169.

HYDRO PLANTS

Large hydroelectric plants offer the most diverse uses. Groundwater reserves are often increased by large dams. A hydroelectric plant can be started and brought to full capacity quickly, so this type of power is being used increasingly for times of peak demand. Also, pumped storage of water between an upper and lower lake during off periods allows for power generation during peak-load times.

There has been renewed interest in locally situated hydroelectric plants. Proposed large facilities are located in sparsely populated areas, and transmission to the locations of use would be highly expensive. Three-fourths of undeveloped hydro-power is in the West, mostly at great distances from population centers.[10] When it is physically possible to provide hydro-power on a local level, it is often still possible to combine uses for a diverse system; for instance, satisfying a need for local flood control or local demand for a recreation site.

SILTATION

One of the important environmental considerations about hydro-power is the fact that rivers carry more than water. They carry particulates that settle out in calm water. In the process of siltation, the river will dump its load of silt into the reservoir at the dam site, and the reservoir will gradually fill up. When the storage capacity of the reservoir is gone, the energy of the waterfall remains, but smaller in amount and subject to changes in the river's flow. The lifetime of a smaller reservoir which is filled by a heavily laden river may be 50 years. Some others may have a useful life of centuries. The average lifetime of a hydroelectric reservoir is about 100 years.[11]

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[10] Tuve, Energy, Environment, Populations, and Food, p. 62.

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[11] Steinhart and Steinhart, p. 169.

(5) Nuclear Energy

Most nuclear power plants are essentially the same as fossil fuel plants.[12] The difference is the primary source. In both systems, the energy source produces steam, which turns a turbine, which drives a generator to produce electricity. The major differences are the initial steps in the production of heat in the nuclear reactor.

NUCLEAR REACTORS

Nuclear reactors all have basic components in common: a fuel supply, a means of fission rate control, and a means of transferring the heat produced in the reactor to where it will be used. There are many variations in design, but the most distinctive feature of any reactor is its design in terms of net energy. A reactor must either be a net consumer or net producer of fuel. By the ratio of fuel produced to fuel consumed, a reactor is classified as a burner, a converter, or a breeder. A breeder reactor is more complex and expensive than a nuclear plant fueled by uranium which has been enriched with extra quantities of radioactive uranium or plutonium isotopes. A breeder reactor converts fuel faster than it consumes it. Therefore, a breeder reactor can be operated on spent fuels from other plants.

BREEDER REACTOR

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[12] Ibid, pp. 134-135.

Currently, there are over fifty nuclear plants in commercial operation in the United States. There are at least another 200 on the drawing board or under construction.[13] Almost one-half of these under consideration have been postponed or canceled due to economics, political pressures, and growing knowledge about problems of radiation hazards and nuclear waste disposal.

NUCLEAR
FUEL

Nuclear fuel reserves are generally referred to in terms of the price per pound of the raw ore, uranium oxide (U_3O_8). This varies according to where it is mined and the costs of extraction and transportation. The table below shows the amounts of uranium oxide available at varying price ranges, according to one estimation.[14]

Price per Pound of U_3O_8	Tons of Known or Suspected Uranium (as U_3O_8) at this Price
less than $8	594,000
$8 to $10	346,000
$10 to $15	510,000
$15 to $30	790,000
$30 to $50	7,760,000
$50 to $100	15,000,000

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[13] Tuve, Energy, Environment, Populations, and Food, p. 138.

[14] Steinhart and Steinhart, p. 138: From Atomic Energy Commission. 1970. "Potential Nuclear Power Growth Patterns," as quoted in H. Hottel and J. Howard, 1971. New Energy Technology. Cambridge, Mass.: MIT Press, p. 34.

The most dangerous aspects of radiation stem not from the uranium itself, but from other members of the uranium disintegration series from which we obtain nuclear energy. People tend not to become disturbed about radiation until they are made aware of exposure without being given a chance to say no. Much of the controversy about radiation standards for the general public and for workers who receive exposure at their occupations stems from the problem of dose-response relationships. It is difficult to create a standard for a threshold dose below which no damage occurs, as the unknown cumulative effects of radiation are still being discovered. Certain radioactive material is dangerous if it enters water supplies or food chains. Gaseous emissions of radioactive materials can also come to earth in precipitation. Nuclear reactors, as any steam plant, also discharge large amounts of waste heat into surrounding ecological systems.

DOSE-
RESPONSE
RELATIONSHIPS

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(6) Synthetic Fuels

The term "synthetic fuels" is generally used to describe those fuels manufactured from other primary resources. Significant fuels are currently manufactured or under exploration to be manufactured from oil and coal.

OIL GAS

Oil gas is made from low grades of oil, has high heating value, and enriches coal gas to the energy quality of natural gas. Bottled gases, such as propane and butane, are also manufactured from petroleum.

COAL CONVERSION

Liquid and gaseous fuels are more versatile than coal. For this reason, the conversion of coal to these forms has become an important issue. There are a a few products under consideration for quantity production. These include:

- "pipeline quality" gas
- lower quality gas for power plants
- synthetic oils for supplementing reserves of petroleum fuels

COAL GAS

With coal most of the newer production processes have multiple stages and yield more than one product. There are several processes for the conversion of coal to gas which are either under consideration or which are currently in the pilot plant stage. The gases which result may be almost pure methane or a mixture of gases with lesser energy quality suitable for generating electricity at the production site.

COAL LIQUIFACTION

There are also plans for large scale production of liquid synthetic fuels. Currently, there are only small facilities in the United States. These fuels would come from the liquifaction of coal. Synthetic gasoline is a major product of these processes.

Environmental problems in the production of synthetic fuels from coal include the increase of surface land destruction through mining and the increased depletion rate of coal resources.

(7) Oil Shale and Tar Sands

Certain types of coal contain less carbon but more hydrogen than other coals. Some of them, when ground and heated, yield a mixture of hydrocarbons resembling petroleum. These are oil shales, a fine textured sedimentary rock. These also are different from normal coals in that they contain a larger amount of inorganic matter.

OIL
SHALES

Most estimates hold that worldwide reserves of oil shale are incredibly large. However, at current rates of consumption, these high-grade ores only represent a 15-year supply.* In this country the major oil shale deposits are in Colorado, Utah, and Wyoming. Much work was done to explore the possibilities of extraction, but final analyses vary with which faction did the exploring. Oil interests, geologists, politicians, or conservationists all have different views on the extraction of oil from oil shales. Uses for the petroleum from oil shales are probably in the petrochemical industry, where the market can bear a higher cost for raw materials, and theoretically there is an opportunity for recycling.

TAR
SAND

Tar sand is an energy source that could be developed in a similar fashion to oil shales. Currently, large amounts of Canadian resources form the major reserves. One estimate says that proposed plants operating at full capacity would use only one-half of these Canadian Athabasca reserves in 1000 years.[15] The U.S. also has small tar sand deposits, mostly in Utah.

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*Steinhart and Steinhart, p. 111.

Athabasca tar sand is a mixture of water, oil, and sand, which holds about 10% oil by weight. These sands are easily accessible by strip mining, as they generally lie about 50 feet below the surface. However, great quantities of water and steam are involved in the extraction process and this poses problems to sensitive tundra and permafrost-dependent ecosystems in the subarctic climate where they are mined.

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[15] Tuve, Energy, Environment, Populations, and Food, pp. 73-74.

(8) Solar Energy

DIRECT SOLAR COLLECTION

There are two basic categories in which to classify solar energy resources. This sub-section focuses on direct collection and conversion of solar energy. The next three sub-sections explore other energy resources indirectly derived from a solar energy base: hydrogen fuel, wind power, and tidal power.

SOLAR CONSTANT

Solar energy is measured in relation to the solar constant.[16] This number refers to the average intensity of sunlight striking the earth's outer atmosphere and measured on a plane perpendicular to its path. The solar constant is 1.36 kilowatts per square meter. The rate of solar intensity will vary with the time of day, latitude, and time of year, all of which affect the angle of sunlight. As a result of reflection, diffusion, and absorption, at different places and due to different climatic and surface conditions, the maximum intensity of solar energy at the earth's surface is reduced (by variations in atmospheric and land conditions) to about 1.2 kilowatts per square meter which is only really reached on clear days at low latitudes at noontime.[17]

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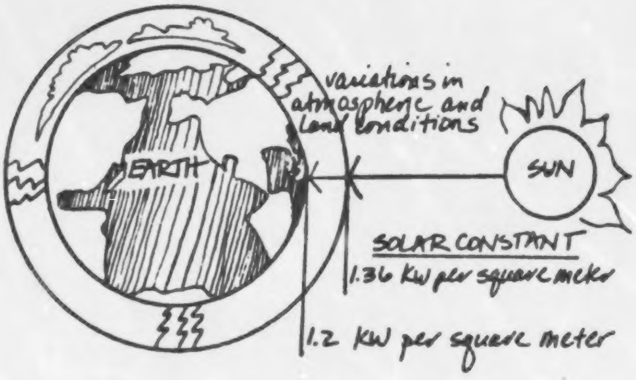
[16] Clark, Wilson. Energy for Survival. New Yrok: Anchor Press, 1974, p. 359.

[17] Steinhart and Steinhart, p. 175.



The two most significant considerations about solar energy are those of energy quality and storage. It is a low quality, or diverse, natural resource and therefore must be collected over relatively large areas. It is also highly dependent on seasonal and climatic conditions and must be stored so that it is available as needed. Solutions to these types of problems are dependent on the final end use for which the energy will be collected.

(a) Small-Scale Uses

Most solar energy uses are found today in the heating and cooling of residences and smaller buildings, and for domestic hot water and refrigeration. The "solar belt," between 45°N and 45°S latitude receives enough sunlight per year to successfully utilize solar energy in this way.[18]

Other small-scale uses for direct solar collection include:

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[18] Ibid, p. 176.

- solar evaporation for the collection of salts;
- solar distillation, where the product is water instead of salt;
- solar air conditioning, which can be coupled to solar heating systems;
- solar ovens and cookers, which have been marketed for some time;
- solar greenhouses, which help to extend a short growing season, and can provide specialized environments for plantings.

(b) Large-Scale Uses

Solar energy for large-scale use can be either collected on the earth's surface or on orbiting satellites. Both methods require large collector areas and full sun.

SOLAR ELECTRIC PLANTS

Most proposals for solar electricity plants involve covering large areas of land, usually deserts, with solar energy collectors. These are built of either vast areas of flat-plate collectors or focused-type collectors, (for higher temperatures). Both types involve transference of heat to a stream of air, water, or other fluid which is circulated to where it will be stored.

PHOTOVOLTAIC CELLS

Photovoltaic cells, which convert sunlight directly to electricity, provide the alternative to surface collection systems. This method is extensively used in space programs. Current photovoltaic systems are also available for small, isolated installations. There are many proposals and experimental projects to develop large solar-cell installations which could be used instead of fuel or nuclear powered plants. Also, there are proposals for orbiting solar power stations which would collect sunlight, convert it to electricity, and convert the electricity to microwaves to be transmitted and reconverted by a large receiving station on earth back to electricity.

(9) Hydrogen Fuel

One proposed solution to problems of solar energy storage involves the production of hydrogen. Hydrogen is produced from water, and on burning, yields only water as a product. It could be stored, distributed through pipelines, and used in ways similar to natural gas.

At high temperatures, water dissociates into hydrogen and oxygen. These two elements tend to recombine unless one of the substances is continuously removed. This process does not allow for an equilibrium state.

If solar energy could be first converted to electricity, then the electricity could be used to separate the water molecules by electrolysis. This process dissociates the hydrogen and oxygen atoms by recovering them at opposite electrical poles.

Both of these methods are still only proposals under exploration and experimentation.

(10) Wind Power

The power of the wind has been harnessed on different scales for centuries, and the technology of windmills is highly developed. However, there has been a serious, revived interest in the use of wind power as a renewable, non-polluting, and non-depletable energy resource on both large and small scales.

The energy of the wind originates in the sun. About 59% of the energy gathered by a windmill is theoretically recoverable.[19] Of course, the major disadvantage of reliance on wind is due to its seasonal and locational limitations. However, unless there is a long-term change in these factors, predictable fluctuations in wind velocity can be handled as part of the system planning.

There are significant numbers of small windmills currently in operation in many parts of the U.S. Some of these were installed before the push for rural electrification, and many others are being installed as households and communities realize the potentials for generating their own power for small-scale needs.

There are many proposals to utilize wind power on a large scale. These range from plans for hundreds of windmills over vast land areas, to large windmills, which are being used in various sites as one-of-a-kind experiments.

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[19] Ibid, p. 162.

(11) Tidal Power

The power of the tides is derived from the energy of the earth-sun-moon system. Most of the expended energy occurs in the oceans, and most of this is in shallow seas, bays, and the mouths of rivers where fresh and salt water mix.[20]

Tidal electric power is a special kind of hydroelectric power. It requires the damming of a partially enclosed basin, the installation of generating facilities, and the alternating filling and emptying of the basin rather than the uni-directional flow of water. The amount of energy available at any particular site can be calculated in relation to the range of the tide and the area of the enclosed basin.

The greatest tidal ranges in the world occur in the Bay of Fundy off the East coast of Canada. A proposal for development here was rejected by the Canadian government on economic grounds, as was a similar proposal for a site off the East coast of the U.S. near Maine. There is currently only one major operating tidal electric plant in the world, in France, which has operated since 1966.[21]

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[20] Ibid, p. 166.

[21] Ibid.

(12) Geothermal Energy

Using the heat from the earth is an indirect use of nuclear energy. The heat from volcanoes, hot springs, geysers, and steam vents originates in the decay of radioactive elements (plutonium, uranium, etc.) in the earth's crust and mantle. There are other forces, such as gravitational energy, and electromagnetic energy at the earth's core, which also have an effect on earth-generated heat. However, that which is available for use by humans and which is most responsible for the earth's face-lifting is that derived from radioactive decay.

HYDRO-
THERMAL
ENERGY

Geothermal heat is found in concentrated zones of certain global systems. These are zones of high volcanic activity, continental rifts, and earthquake activity. They are often characterized by large underground storages of steam and hot water. Technically speaking, the energy that is feasible to use commercially is hydro-thermal energy, the energy of hot water, rather than geothermal energy, the energy of hot or molten rock. But all of these types of earth energy are commonly referred to as geothermal.

There are currently few producing geothermal facilities in the world. One is in California, the Geysers Project, which was begun in 1955. There is much research being done in this field, both involving exploration for buried resources and the determination of their rates of natural replenishment. Also, work is being done on the efficiency of upgrading the low-quality steam power usually derived from geothermal sources.

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(13) Biomass

Biomass conversion is based on the principles of waste recovery and recycling. Among other processes, it involves the utilization of human and agricultural wastes as fuels and as secondary resources. Currently much work is being done in the exploration of ways to improve the treatment of wastes as fuels.

A by-product of the sugar cane industry, bagasse, is often used in the manufacture of paper. Other agricultural wastes which were once burned are being converted to fertilizer, feed, and food supplements. It is also possible to convert organic wastes to methane. In Europe, much of the solid waste is burned to generate electricity. There are other new processes under investigation which would be able to convert garbage to high-quality gas or liquid fuel.

Below is a chart indicating available, collectible organic wastes that might have been used for fuel production in the U.S. in 1971.[22]

Waste Source	Total Available Amount of Waste Generated in Millions of Tons	Amount that Could Have Been Collected for Fuel in Millions of Tons
Manure	200	26
Urban refuse	129	71
Logging, wood residue	55	5
Agricultural crop and food wastes	390	22.6
Industrial waste	44	5.2
Municipal sewage	12	1.5
Miscellaneous organic material	50	5
	880	136.3

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[22] Larry L. Anderson, "Energy Potential from Organic Wastes: A Review of the Quantities and Sources," Bureau of Mines Information Circular #8549, Washington D.C.: U.S. Bureau of Mines (1972) cited in Clark, Wilson, Energy for Survival, p. 459.

(14) Miscellaneous Energy Converters

Several developments in the energy field do not really qualify as resources, but rather as improvements in energy conversion. These include:

- MHD or plasma generators which convert fuel combustion energy directly into electricity by means of an ultra-high-speed plasma tunnel with powerful external magnets.
- Fuel cells which are electric batteries with a fuel input. Hydrogen has many advantages as the fuel, and a hydrogen-oxygen fuel cell is already highly developed for use in space programs.

ACTIVITY

FACILITATING NOTES

Activity: Resource Matrix

1. Divide the readings appropriately among the group.
2. The group may wish to make copies of the charts in Miller and other appropriate readings.
3. Read at least one of the readings in depth, and skim the others, to gain perspectives on differing points of view.
4. Answer the questions on the chart in a simple, brief manner, using the example given as a reference. There is an abundance of material, so make sure the group focuses on the questions in #3 to help weed out extraneous information.
5. Do the discussions (#4-7) as a group exercise to facilitate consideration of controversial issues.

OBJECTIVES: (c) Become familiar with the types of conventional and nonconventional energy resources.

(d) Understand important considerations in selecting energy resources for development and delivery.

READING: Ehrlich, Paul; Ehrlich, Anne, and Holdren, John. Ecoscience. San Francisco: W.H. Freeman and Co., 1977. pp. 400-411, 471-480.

Miller, G. Tyler. Living in the Environment. Belmont: Wadsworth Publishing Co., 1975. pp. 231-232 (Tables 13-2 and 13-3).

Steinhart, Carol and Steinhart, John. Energy: Sources, Use, and Role in Human Affairs. North Scituate, Mass.: Duxbury Press, 1974. pp. 89-186.

TO DO:

1. Refer to the energy resources described on p. 41. The group should then choose any two from #1-5, and any two from #6-13. Divide these among the group.
2. Have subgroups read the appropriate sections on each resource in Ehrlich and Steinhart, and all teachers refer to the Tables in Miller, pp. 231-232. Focus your reading on the questions below to help screen out extraneous information.
3. Each subgroup answers the following questions about their resource by filling in the matrix on page 73. One example is provided in brief form.
   - Is the resource renewable or non-renewable? Include a short statement about the nature of the resource that indicates a reason for its renewability or non-renewability.
   - What are some of the final energy uses of this resource?
   - What are some advantages to using this energy resource?

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- What are some disadvantages?
- What are some effects of using this energy resource? List any environmental, economic, social or political effects you can think of.

4. As a group, discuss the similarities and differences between these aspects of each resource. You may want to fill in the blank spaces on your own charts for each resource.
5. After the group discussion, list the resources you chose for this activity in decreasing order with respect to environmental impact.
6. List these in decreasing order with respect to potential supply.
7. Discuss which ones seem to offer the best compromise between availability and environmental impact.

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RESOURCE	RENEWABLE/ NON-RENEWABLE	USES	ADVANTAGES	DISADVANTAGES	EFFECTS
Coal	Non-renewable; in ancient forests formed from compacted, decayed plant material	Electricity Coal gas Oil gas	Easy extraction Large reserves Feasible large-scale mining	Uses much water Residues and solid wastes in high quantity Mine safety factors	Long lead times for implementation Higher costs of power for consumers

SECTION 3

RESOURCES

Clark, Wilson. *Energy for Survival*. New York: Anchor Press, 1974.

Commoner, Barry. *Poverty of Power*. New York: Alfred A. Knopf, 1976.

Ehrlich, Paul; Ehrlich, Anne; and Holdrens, John. *Ecoscience*. San Francisco: W. H. Freeman and Co., 1977.

Gilliland, Martha (Ed.). *Energy Analysis: A New Public Policy Tool*. Boulder, CO: Westview Press, for the American Association for the Advancement of Science, 1978.

Lovins, Amory B. *Soft Energy Paths*. San Francisco: Friends of the Earth, 1977.

Miller, G. Tyler. *Living in the Environment*. Belmont, CA: Wadsworth Publishing Co., 1975.

Odum, Howard T. "The Ecosystem, Energy, and Human Values," *Zygon*, Vol. 12, No. 2 (June, 1977).

Odum, Howard T.; and Odum, Elisabeth C. *Energy Basis for Man and Nature*. New York: McGraw-Hill Book Co., 1976.

Steinhart, Carol; and Steinhart, John. *Energy: Sources, Use, and Role in Human Affairs*. North Scituate, MA: Duxbury Press, 1974.

Scientific American, "Energy and Power". San Francisco: W. H. Freeman and Co., 1971, Chap. 7.

SECTION 3

ENERGY RESOURCE DELIVERY SYSTEM

After completing Section 3, you will:

(e) Understand the energy principles which drive an energy resource delivery system.

(f) Understand the optimal design of a delivery system in relation to the nature of an energy resource and energy end use.

We cannot get much work out of resources in their raw form. Having examined the nature of energy resources, we now use this information as a background to view the manner in which we obtain and process raw materials for use as energy fuels. In this section, we also introduce some principles and concepts necessary to the discussion and evaluation of energy issues.

The series of processes needed to change a raw fuel into useful work is called an energy delivery system. We cannot get much work out of fuels in their raw form. Therefore, an energy resource must be processed into a useable form and then transformed into work through some mechanical, chemical, or electrical process. Also, different resources have differing energy qualities requiring varying amounts and types of processing in order to perform useful work.

To provide a framework for comparison of different energy resource delivery systems, we can define eight basic stages of the energy delivery process, from initial collection of the primary resource to final energy end use. These stages may not apply to all delivery systems, and some systems may exhibit more than one process in each stage. Each system is dependent on two major factors: (1) the nature of the energy resource, and (2) the end use for which the final product is required. Figure 3 shows this general organization of energy resource delivery. Using this framework, we can examine various energy resource delivery systems.

As energy moves through an energy delivery system, there is an increase in unit energy quality available. This means that, in each stage, we find an increase in flexibility or possible diversity for energy use.[1] We can see that at each step in the delivery system, there is an upgrading of the resource to result in a more concentrated energy form. The complexity and length of a delivery system is dependent on the final end use, or required energy quality for work.

END USE

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[1] See the discussion on energy quality which follows on pp. for an elaboration of this concept.

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At the end of this section, we present a visual comparison of different energy resource delivery systems. In the forthcoming materials, we refer back to these charts and define delivery systems according to specific criteria of judgment, in order to make an overall assessment of delivery strategies.

(1) Conventional Energy Resource Delivery Systems (Fig. 6) p. 101. This matrix compares seven delivery systems developed in the U. S. to satisfy the demands of our contemporary social systems. Certain historical developments are excluded in this diagram, such as wind power and solar heat, because they do not feed any appreciable amount of energy into our consumer system as it currently exists.

(2) Nonconventional Energy Resource Delivery Systems (Fig. 7) p. 103. This matrix utilizes the same framework to present other types of resource delivery systems. These are either being used on a noticeable scale or are being researched and explored as proposed alternatives to current delivery strategies. We will not discuss the differences between this matrix and Fig. 3 at this point. However, the suggested activities at the end of this section serve as a prelude to assessments and comparisons which take place in the following sections.

The general organization of energy delivery systems is in eight stages from primary resource site to end use:

Fig. 1 Energy Resource Delivery

STAGE	SAMPLE ENERGY DELIVERY SYSTEMS	
	OIL TO ELECTRICITY	WHEAT TO BREAD
1. EXPLORATION: siting of resource deposits, basic research and development of exploratory techniques, machinery	Geologic exploration for oil	Agricultural chemist's search for improved method of wheat production
2. EXTRACTION: removing the resource, machinery and site equipment, materials, operating agencies, maintenance over the life of the site	Tapping oil well	Harvesting wheat
3. TRANSPORT I: transportation mechanisms and operating energy necessary to carry the resource to the next facility	Shipment of crude oil	Trucking of grain
4. PROCESSING: energy to run machinery, construction of the facility, its maintenance and operating energies	Processing of crude oil	Grinding of grain
5. TRANSPORT II: transportation systems and the operating energies required to move the resource to the conversion plant	Shipment of partially refined oil to a regional refinery	Trucking of flour to baker
6. CONVERSION: plant construction, materials and maintenance	Transformation of oil into electricity	Transformation of dough into bread
7. DISTRIBUTION: energy costs, equipment, storage facilities and networks to move the converted product from final facility to point of consumption	Sale of electricity to a household	Sale of bread at grocery store
8. END USE: Input to the "basic human needs" system	Operate electric toaster	Eat the bread

a. A System of Energetics

ENERGETICS

Energetics is the process by which we examine and depict the structure and processes of an energy delivery system. There are general principles of energetics--based primarily on the Laws of Thermodynamics--with which we can create a representation of energy systems.

PRINCIPLES OF ENERGETICS

It is important to our discussions that we acknowledge the role of energetics as a valuable tool for asking the right questions about energy delivery and use. We live with the assumption that energy in in its various forms is good for something, that it is essential in performing certain work-requiring tasks. Energetics requires that we question the nature of the assumption by asking: What are certain energy forms good for? Energetics requires that we ask questions about the relationship between an energy resource and the work it performs. For instance, how much of the energy resource is converted to work, and how much is lost to heat or light?

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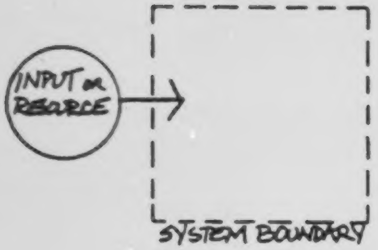
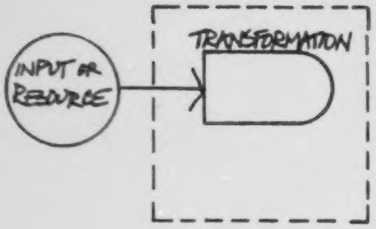
FIG. 2

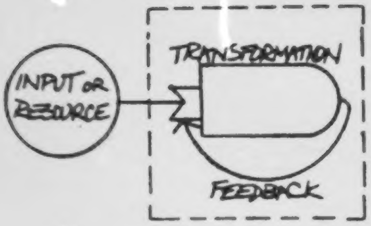
There are four major operations of energy systems:



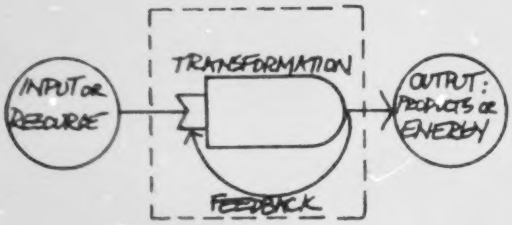
- Input operations provide resources for the interactions between the system and its environment. This is accompanied by the identification of system-relevant input, and the consequent activation of the system.



- Transformation implies operations that bring about conditions by which the input will be transformed into the output.



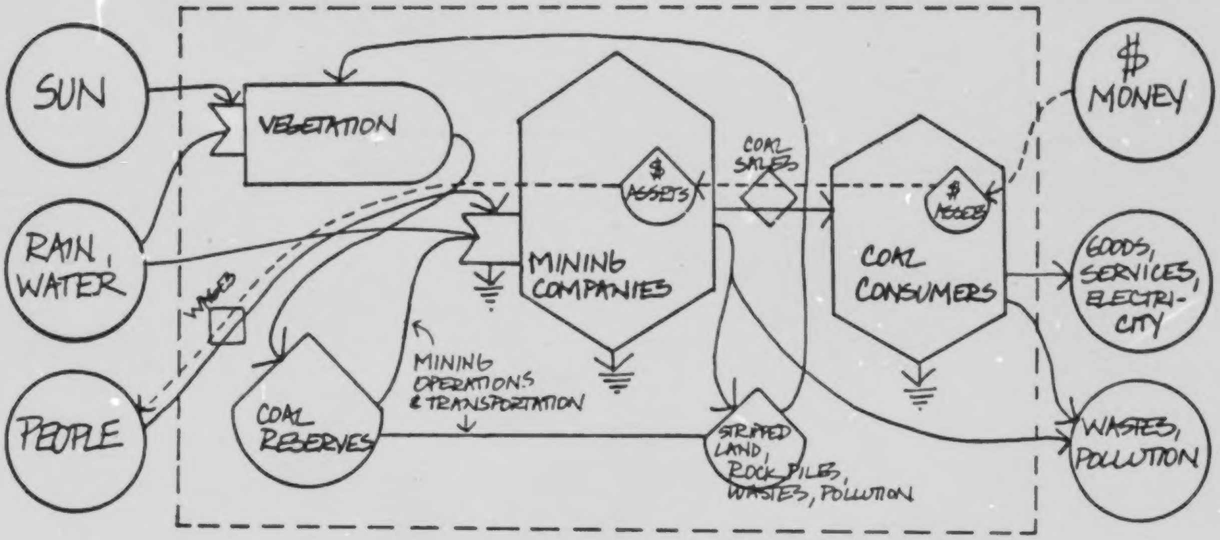
- Feedback and adjustment analyzes and interprets information relevant to the output and, if indicated, introduces adjustments in systems operations in order to achieve a more adequate output.



- Output processing implies operations that identify and assess environmentally relevant output, and the interaction necessary between the system and its environment to introduce the output into the environment.

FIG. 3

Below is a simplified diagram of some parts of a coal mining system for energy delivery:

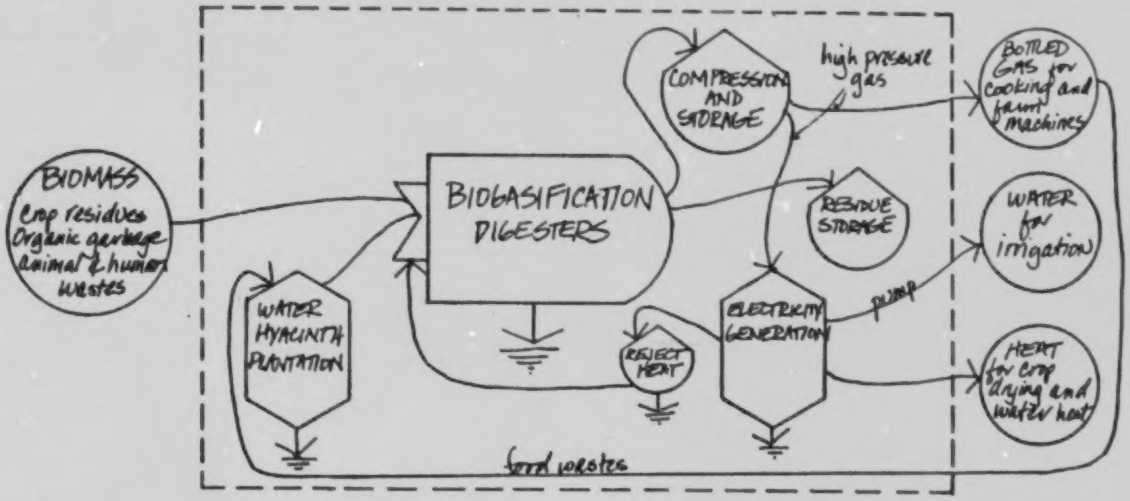


A COAL MINING SYSTEM

Coal is produced by the deterioration and compaction of organic materials. It is mined, then shipped by barge or rail to be used in power plants (coal consumers). Pipelines that carry slurries (coal and water) of coal are often used for transportation instead of railroads. Coal burning creates by-products (such as ash or acid vapor) from smokestacks, which must be dispersed. These pollutants have residual effects on the surrounding landscape and architecture.

FIG. 4

Another example of an energy delivery system is this simplified diagram of a small-scale biogasification and electricity system:



Biogasification takes place in enclosed volumes of various designs called digesters, which efficiently handle the wastes: from various size towns, livestock feedlots, and other sources. The gas, with the removal of carbon dioxide (CO_2), is almost pure methane, suitable for cooking, heating, and electricity generation in units of many kinds and sizes. Farm machinery can be modified to burn methane instead of gasoline.

b. A Basis for Energetics

THERMODYNAMICS

Thermodynamics, from the Greek roots therme--heat, and dynamis--power, is the applied science that defines and interprets the relationships between energy, heat, and work.[2] The principles of thermodynamics arose from evidence that energy conversions vital for the maintenance of the energy systems of humanity and nature obey certain laws--no matter what process or energy source is involved. These principles have to be taken into account when describing the behavior of any system using energy in any of its forms.

The concepts outlined in the laws of thermodynamics give us the capability of measuring the two basic attributes of energy--its quantity, and its ability to do work. Our purpose in introducing thermodynamics is to help us learn how energy can be most efficiently matched to work-requiring tasks. As Commoner put it: "The practical value of thermodynamics is that it can teach us how to mobilize energy and most effectively use it to generate the activities of civilized life.[3]

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[2] Clark, Wilson. Energy for Survival, p. 9.

[3] Commoner, Barry. Poverty of Power. New York: Alfred A. Knopf, 1976, p. 24.

PRINCIPLES OF THERMODYNAMICS

First Law: Energy is neither created nor destroyed; or, "the energy of the universe is constant."[4]

Second Law: In energy processes, there is a continuous degradation of energy from higher to lower forms.

(1) The First Law

CONSERVATION OF ENERGY

The first law of thermodynamics was established after the British scientist James Joule measured the exact relationship between heat and work. This law shows the basic conversion from kinetic energy to heat. It accounts for the heat generated by friction and motion in work. The first law is also called the Law of Conservation of Energy.

We have heard this law restated recently in these terms: "You can't get something for nothing;" and "There is no such thing as a free lunch."

(2) The Second Law

ENERGY DEGRADATION

The Second Law of Thermodynamics is the most important to the development of efficient energy resource delivery. It is also called the Principle of Energy Degradation or the Entropy Law.

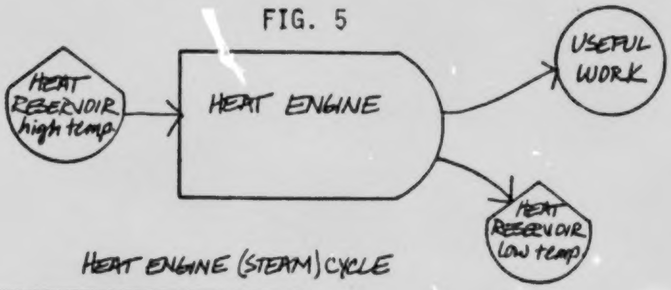
The first law tells us that the energy of the universe is constant. However, in any real process, some potential energy becomes lost. It is degraded from a useful form of energy capable of driving a function to a form that has lost that capability.

HEAT SINK

This principle was developed by the Frenchman Carnot while testing the efficiency of heat engines. He discovered that for the most efficient steam engine, heat should be supplied at the highest possible temperature at the heat source, and should be rejected at the lowest possible temperature at the heat sink, or point of energy loss.

Below is a simple diagram illustrating Carnot's principle.[5]

FIG. 5



HEAT ENGINE (STEAM) CYCLE

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[4] Commoner, Poverty of Power, p. 28.

[5] Adapted from Clark, Wilson, Energy for Survival, p. 11.

C. The Principles of Energetics

PRINCIPLES OF ENERGETICS

Based on the energy operations outlined on p. 82 and the Laws of Thermodynamics, H. T. Odum outlines four major principles of energetics:[6]

FEEDBACK

(1) Feedback Interaction

The feedback is high-quality energy (waste, heat, or storage) that is amplified by interacting with the original energy source. Storage is a necessary feature of controlling the rate and amount of feedback.

(2) Material Cycle, Order, and Disorder

> "When Humpty Dumpty converted his potential energy of position first into the kinetic energy of falling and then into the heat of impact and the mechanical energy of scrambling, he was pursuing the inevitable course that all things take. Furthermore, although in theory it is possible to restore Humpty to his original condition through appropriate inputs of energy, in practice there is no way to unscramble a scrambled egg."[7]

Materials move along with the energy from a disorderly state, interacting with an energy source to develop orderly products in storage. As required by the law of energy degradation (the second law of thermodynamics), energy storages disperse concentrated energy into a diffuse or disorderly state, as indicated in the quote above.

ENTROPY

Entropy is a term derived from a Greek word meaning transformation.[8] This term describes the process that causes available energy to continuously change to a lower form. In entropy terms, the Second Law of Thermodynamics can be restated as follows: The universe tends toward the state of maximum entropy. Clark calls entropy the "energy gravity" of the universe.[9] This principle is used to describe the behavior of all the systems of nature and humanity.

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[6] Odum, Howard T. "The Ecosystem, Energy and Human Values," Zygon, Vol. 12, No. 2 (June, 1977), pp. 112-117.

[7] Steinhart and Steinhart, p. 49.

[8] Clark, Energy for Survival, p. 12.

[9] Ibid, p. 13.

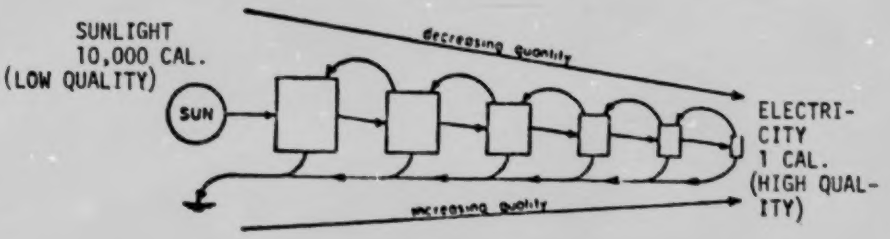
Entropy is a measure of the unavailability of energy for work. It is a measure of a system's tendency toward disorder, dispersion of energy, and loss of information.[10] Clark likens a deck of cards to a system representing order, or low entropy.[11] It has a high stock of potential energy. When the cards are scattered, it would require more energy to pick them up and rearrange them into a deck again than the original energy it took to scatter them. When they are on the floor, they are in a state of high entropy.

(3) Energy Quality

ENERGY QUALITY

Energy quality is a measure of a substance's potential to do work. Higher quality energy forms such as electricity have received a lot of upgrading in order to increase this potential or flexibility. The quality of an energy form refers to the diversity of different purposes it can be used for; energy forms of higher quality exhibit greater flexibility. For example, electricity is much more versatile an energy than sunlight or wood; top carnivores in food chains are more versatile in their feeding habits and services to the system than the algae or the primary consumers.

The drawing below depicts a typical energy chain as found in food chains in ecology, occupational chains in industry, chains of physical processes in the ocean and atmosphere, and energy resource delivery systems.[12] At each state, energy is transformed to a new type that is capable of feeding back as a multiplier. In achieving higher quality energy and ability to control, energy is used and leaves the chain through the used-energy arrows to the heat sinks. There may be no more than 10 percent of the entering energy remaining beyond each transformation, but the quality goes up with each step. In a long chain there may be ten thousand calories of low-quality energy such as sunlight converted into one calorie of high-quality energy such as electricity. On the left, flows are large as measured in calories of heat equivalence, whereas the flows on the right are few in calories but large in impact, acting as an amplifier when they feed back.



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[10] Commoner, Poverty of Power, p. 29.

[11] Clark, Energy for Survival, p. 14.

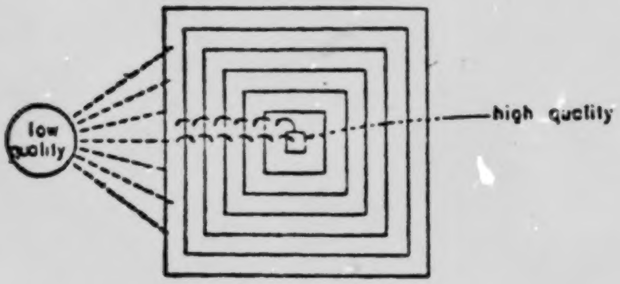
[12] Odum, H. T., Zygon (12:2), p. 15.

ENTHALPY

Enthalpy is a measure of the quantity of available energy or possible work contained in a resource or system, without regard to its quality or energy form. For example, in terms of enthalpy,"...there is more energy in the form of low temperature heat in the Atlantic Ocean than in the form of oil in the Persian Gulf, but it is such low quality (high entropy) that it could not be used to do difficult kinds of work as oil could."[13]

(4) Information, Spatial Concentration

From the following diagram, notice that the upgrading of energy quality is accompanied by the concentration of energy into smaller geometric space.[14] For example, collecting solar energy concentrates higher quality energy into less calories for smaller populations (see diagram for #3 above). The highest quality energy flows are those which carry information--because information flows have the most diverse impact in a feedback interaction. Information affects the largest number of people--using high quality, low quantity energy.



(5) The Maximum Power Principle

MAXIMUM POWER

In addition to those principles of energetics outlined by Odum, there is another principle that is often referred to as the "third law of thermodynamics": The Maximum Power Principle. It is an explanation of why certain systems survive over others.

Ecological systems, as they go through their succession of dynamic patterns, increase their degree of orderliness, develop better cycles, improve their control mechanisms, and form patterns that increase their productivity and consumer energy flows. Order and disorder are coupled: in order to achieve maximum power, a system requires some of each.

The Maximum Power Principle says that more lasting and more probable dynamic patterns of energy flow or power (including the patterns of living systems and civilizations) tend to transform and restore the greatest amount of potential energy at the fastest possible rate. For each step in a system's function this requires that up to 50 percent of the flow from potential energy storages be expanded into the pool of energy dispersion and at least 50 percent transformed into a new storage of energy available for a future process, one of higher quality.

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[13] Lovins, Amory. Soft Energy Paths: Toward A Durable Peace. San Francisco: Friends of the Earth International, 1977, p. 224.

[14] Odum, H. T., Zygon (12:2), p. 115.

The application of this principle to new energy or social systems developing in an environment of abundant resources generates competition between rival systems or subsystems to capture the most energy. The application of this principle to mature energy or social systems that are in "steady state," or in balance with the resources of their environment generates cooperation.

d. Energy Efficiency

ENERGY EFFICIENCY

The second Law of Thermodynamics also provides a basis for measuring energy performance by describing the energy efficiency between the energy resources or input, and the physical production or output of a delivery system. Barry Commoner calls this "Second Law Efficiency."[15] This efficiency can be expressed as a ratio:

$$\text{EFFICIENCY} = \frac{\text{useful work or energy output}}{\text{energy input}}$$

For example, an electrical power plant fueled by oil, gas, or coal has an efficiency of about 33% because it takes 3 units of fuel energy to produce one unit of electricity:

$$\frac{\text{energy output}}{\text{energy input}} = \frac{1\ \text{unit}}{3\ \text{units}} = 33\%$$

PRODUCTIVITY

Productivity uses the same ratio, expressed as a unit of output per unit of input, although the two types of units are not the same. This ratio is often used to describe energy/economic relationships, for example:

$$\text{productivity} = \frac{\text{energy produced by the system (in kilowatt-hours)}}{\text{energy costs to system (in dollars)}}$$

ENERGY QUALITY FACTOR

ENERGY EQUIVALENTS

The energy efficiency ratio of the energy input and output is also called the energy quality factor. To help compare energies of different quality located in different parts of the energy chain on earth, tables of energy equivalents were developed for converting all energies to the same quality, such as: "coal equivalents"--the amount of work stored in a standard unit of coal--or "solar equivalents"--the amount of energy in a particular solar unit. This value and the ability to do work contribute to maximum power and thus contribute to the survival of a system.

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[15] Commoner, Poverty of Power, p. 177.

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e. Net Energy Analysis

Energy production is one of many economic activities in our society. The motive for producing energy is simple enough: if it can be sold for more than it costs to produce, then it is a profitable enterprise. In economic terms, we can say that if the revenue a producer gets from selling energy is greater than his cost of production, then he earns a net profit. If he could not get a high enough price and had to sell below cost, then the operation produces a net loss. These economic concepts are easy enough to understand. Total revenues are the gross profit, costs are subtracted to find the net profit.

A similar accounting technique has arisen to analyze the feasibility of energy production processes and delivery systems in terms of energy concepts. Since a greater part of society's wealth must now be spent on energy, society as a whole must be more "profit" conscious. While one producer may be able to sell energy profitably at a high price, society may not be benefiting from the production of that energy. From this concern over society's energy profit, a new field of analysis has developed which considers the net gain in energy associated with energy production. The name given to this school of thought is net energy analysis.

NET ENERGY ANALYSIS

The concept of "net energy" and methods of "net energy analysis" have gained widespread use in recent years along with discussions of the "energy crisis" and energy conservation. The basic ideas of net energy, those of technical and process efficiency for energy production systems, have been common elements in the fields of physics and engineering for many years. Net energy analyses, however, have expanded these ideas beyond the traditional boundaries of technical analysis.

Just as an energy delivery system can be analyzed for its economic profitability, it can also be analyzed for its energy profitability, it can also be analyzed for its energy profitability. Net energy analysis is an accounting technique which looks at the energy resulting from a particular chain of energy production activities and compares the results to the total amount of energy used to drive that chain of activity. When energy output is compared to total energy costs, we can determine the *net energy profit* of the particular gross energy production.

NET ENERGY
PROFIT

We can compare two energy systems by comparing their net energy profit. We determine net energy profit as follows: *gross energy output minus total energy costs equals net energy profit*. Since different forms of energy are typically measured in different units, such as barrels of oil, cords of wood, kilowatts of electricity, we need some way to mix energy "apples and oranges" into common units. There are two ways to do this.

(1) The first way is to eliminate units altogether by defining ratios. We defined energy efficiency previously (see p. 91). Recall that this gives us a percentage of useful energy left after a fuel is converted to work. In a net energy analysis, we are concerned with the overall efficiency of the entire energy production and delivery system. We can define a new efficiency ratio for the whole system, the *energy yield ratio* and then compare these ratios for different delivery systems.

ENERGY
YIELD
RATIO

$$\text{energy yield ratio} = \frac{\text{energy produced by the system}}{\text{energy costs of operating the system}}$$

For the examples of oil and nuclear-powered electricity, the yield ratios are approximately the following:

$$\text{yield ratio} = \frac{\text{yield}}{\text{costs}}$$

30/1 for oil ("old" oil)
6/1 for oil (Alaskan)
2.4/1 for nuclear

Since ratios of like measures have no units associated with them, we can compare different energy delivery system alternatives by calculating their energy yield ratios. The higher the ratio, the more net energy is produced.

(2) Another way to compare energy in different forms is to consider their qualities of energy. We have introduced the concept of energy quality on p. 88. Recall that energy quality is a measure of a substance's ability to do work. When we examine an energy system, we look at the energy quality exhibited by different energy forms. A calorie of dispersed heat cannot do work, a calorie of sunlight can do work if it is collected, a calorie of coal is already highly concentrated and can do much useful work. Each of these energy forms has different qualities.

In doing any net energy analysis, it is important to keep in mind the qualities of different energy forms. For example, it may take barrels of oil, kilowatts of electricity, and calories of steam to operate an electrical production system. These must all be put into common terms and corrected for quality, such as converting everything to coal equivalents or solar equivalents (see p. 91.

Net energy analysis, as a consistent and accepted technique, is still in the stage of development and promotion by different advocates. There are areas of disagreement between different proponents and several points of criticism by outsiders. While there is no one specific accepted methodology, the general idea of net energy analysis (of resource delivery systems) has received positive recognition as an important input to energy policy decisions.

ACTIVITY

FACILITATING NOTES

1. This section constitutes a major focus for the module. Be sure that your group grasps the basic concepts of an energy resource delivery system and its stages, as well as the notions of energy efficiency and net energy. Refer as much as possible to the readings in the exercises to clarify aspects of these concepts.

2. Your group may wish to make copies of Odum and Scientific American and appropriate readings for each subgroup. In the subgroups, teachers should read at least one of the readings in depth, and skim the others to gain a perspective of different points of view.

3. Answer the questions on the chart in a simple, brief manner, using the example given as a reference. Teachers will find an abundance of material, so make sure your group focuses on the questions in #4 to help weed out extraneous information.

ACTIVITY

OBJECTIVES: (e) Understand the energy principles which drive an energy resource delivery system.

(f) Understand the optimal design of a delivery system in relation to the nature of an energy resource and energy end use.

READINGS: *Ehrlich, Paul; Ehrlich, Anne; and Holdren, John. Ecoscience. San Francisco: W. H. Freeman and Co., 1977, pp. 400-484.

Odum, Howard T.; and Odum, Elisabeth C. Energy Basis for Man and Nature. New York: McGraw-Hill Book Co., 1976, p. 78-87.

Scientific American, Energy and Power. San Francisco: W. H. Freeman and Co., 1971. "The Flow of Energy in an Industrial Society," Earl Cook, Chap. 7, pp. 83-91.

*Steinhart, John; and Steinhart, Carol. Energy: Sources, Use and Role in Human Affiars. North Scituate, MA: Duxbury Press, 1974, pp. 91-210.

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*Only applicable sections in these references will be read.

TO DO:

1. All teachers complete the readings from Odum and Scientific American.

2. Choose four resources other than those you used for the Activity in Section 2. Refer to Figs. 6 and 7.

   2 from the Conventional Energy Resource Delivery Chart (Fig. 6).

   2 from the Nonconventional Energy Resource Delivery Chart (Fig. 7).

3. Divide these among your group for research purposes. Individuals or subgroups should read the appropriate sections in Ehrlich and Steinhart to gain a sense of the perspectives of the authors. You will probably see differences in their approach to controversial issues. Remember to focus on issues related to energetics and the delivery system for each resource to be able to complete this exercise.

4. Subgroups trace these resources through the appropriate Delivery Systems Charts (Fig. 6 or 7) and answer the following questions for each resource system by filling in the

accompanying chart. One example is provided in brief form.

- What is the original energy quality of the resource? (For example, coal is a concentrated energy form, with high energy quality, while sunlight is diffuse, with low original quality.)
- At what stages of delivery are there losses of potential energy to degradation or physical waste? What types of energy losses could occur at these stages?
- What are the final energy uses of this resource?
- What stages of delivery have the potential for recycling or conservation efforts? What would they be?

5. As a group, discuss the similarities and differences between these aspects of each resource delivery system. You may want to fill in the blank spaces on your own charts for each resource system.

6. Using the resource systems you chose for this Activity, list these in decreasing order with respect to potential energy loss.

7. List these in decreasing order with respect to potential recycling or conservation.

8. Discuss which ones seem to offer the best compromise between potential recycling or conservation and potential energy loss.

DELIVERY STAGE ENERGY RESOURCE	EXPLORATION	EXTRACTION	TRANSPORT I
PETROLEUM	Seismic or other exploration for oil deposits, exploratory drilling and estimation of reserves	Drilling and operation of oil wells	Transport of crude oil to refineries by pipeline, tankers, trains, or trucks
NATURAL GAS	Geological exploration and drilling to locate gas reserves, often in conjunction with petroleum exploration	Production of natural gas from gas or oil wells; separation of gas from oil	Transport of natural gas to processing stations by pipeline
LIQUIFIED NATURAL GAS (LNG)	Geological exploration and drilling to locate gas reserves, often in conjunction with petroleum exploration	Production of natural gas from gas or oil wells; separation of gas from oil	Transport of natural gas to processing by pipeline
COAL (TO ELECTRICITY)	Geologic exploration and siting of underground and surface coal deposits; estimation of deposit size	Construction and operation of underground or surface mines	Transport of raw coal to cleaning facilities by conveyor, slurry pipeline, truck or unit trains
HYDROELECTRIC POWER	Location and assessment of rivers with hydroelectric potential	Construction of a dam and associated turbines and generators	NA
NUCLEAR ENERGY (CONVERTER REACTOR)	Geologic/radioactive location of uranium deposits	Mining of uranium ore and milling to produce U_3O_8	Transport by special container on trucks or trains to processing facilities
NUCLEAR ENERGY (BREEDER REACTOR)	Geologic/radioactive location of uranium deposits; also utilization of ore tailings from converter reactor fuel processing	Mining and milling of uranium ore; extraction of plutonium from spent reactor fuel; reclamation of ^{238}U tailings from converter reactor fuel enrichment process	Transport of uranium and plutonium in special containers by trucks or trains to processing facilities

[1] NOTE: ASTERISKS IN THIS SECTION INDICATE A BROAD SCALE OF COMPLEXITY IN PROCESSING

* SIMPLE
** MORE COMPLEX OR INTENSIVE
*** HIGHLY COMPLEX

Figure 6

CONVENTIONAL ENERGY RESOURCE DELIVERY SYSTEMS

(continued on next page)

1 7

PROCESSING[1]	TRANSPORT II	CONVERSION	DISTRIBUTION
Refining of crude oil into various products **	Transport of refined products by pipeline, train or truck to conversion facilities or distribution points	Direct combustion in industrial boilers or production of heat to power or steam-turbine electrical generation plant	Transmission via the electrical grid or by service station, fuel oil, etc., facilities for liquid products
Processing to remove contaminants and liquids *	Transport to conversion facilities or end-use location by pipeline	Direct combustion to produce steam to power or steam-turbine electrical generation plant	Transmission via the electrical grid or by pipeline to direct uses
Processing to remove contaminants and liquids; liquifaction **	Transport by LNG tanker to coastal ports	Vaporization (return to gaseous state)	Distribution by pipeline to direct end-uses or to further conversion to electricity
Cleaning of raw coal to remove impurities and, if applicable, separation from slurry fluid *	Transport of clean coal to conversion facilities by conveyor, truck, or unit train	Direct combustion to produce heat to power or steam-turbine electrical generation plant; or gasification of coal then used for electrical production or for other gas uses	Transmission via the electrical grid or gas pipelines for coal gas
NA	NA	Operation of the power plant at the dam	Transmission via the electrical grid
Enrichment of ^{235}U in U_3O_8; fabrication of fuel rods; reprocessing of spent fuel; waste disposal ***	Shipment of fuel rods by guarded train	Production of steam from fission heat to power electrical generating turbines	Transmission via the electrical grid
Fabrication of fuel rods from uranium and plutonium; waste disposal ***	Transport of fuel rods in special guarded containers by train	Production of steam from fission heat to power electrical generating turbines	Transmission of electricity via the grid

(continued from previous page)

DELIVERY STAGE

ENERGY RESOURCE	EXPLORATION	EXTRACTION	TRANSPORT [1]
COAL (GASIFICATION)	Geologic exploration and siting of underground and surface coal deposits; estimation of deposit size	Construction and operation of underground or surface mines	Transport of raw coal to gasification plant by conveyors, slurry pipeline, truck, or unit train
COAL (LIQUIFACTION)	Geologic exploration and siting of underground and surface coal deposits; estimation of deposit size	Construction and operation of underground or surface mines	Transport of raw coal to liquifaction plant by conveyor, slurry pipeline, truck, or unit train
OIL SHALE	Geologic location and assessment of oil shale deposits	Construction and operation of oil shale mines and retorting facilities; or in situ retorting of shale	Transport of oil shale to retort facilities by truck or pipeline (not applicable for in situ retorting)
TAR SANDS	Geologic location and assessment of tar sand deposits	Construction of tar sand extraction facilities; extraction by slurry mining or in situ	Transport of tar sands to processing site (not applicable for in situ recovery)
SOLAR ENERGY (SMALL SCALE)	Location of sunward exposures for placement of collectors or windows	Erection of sunlight collecting devices or construction of windows and storage medium	Piping of heat collection fluid to house or other site; storage
SOLAR ENERGY (LARGE SCALE)	Location and assessment of areas with proper solar insulation	Construction of large sunlight collection surfaces, central boiler, and steam-electric generation system	NA
PHOTOVOLTAIC CELLS	Location of required minerals, e.g., silicon	Mining of required materials	Transport of minerals to production facilities

1: COMPLEXITY SCALE: PROCESSING
* SIMPLE
** MORE COMPLEX OR INTENSIVE
*** HIGHLY COMPLEX

Figure 7

NONCONVENTIONAL ENERGY RESOURCE
DELIVERY SYSTEMS

(continued on next three pages)

PROCESSING[1]	TRANSPORT II	CONVERSION	DISTRIBUTION
Production of synthetic natural gas from coal by gasification, hydro-gasification, or pyrolysis; gas purification; and production of methane **	Transport of coal-gas by pipeline to conversion or end-use site	Direct combustion of gas for space heating close to processing site, or production of electricity by combined gas-steam turbine	Transmission of electricity via the grid
Production of synthetic petroleum by the synthesis gas process, pyrolysis, or hydrogenation **	Transport of liquid and some gaseous products to conversion or end-use sites by pipeline	Direct combustion as petroleum fuels or production of electricity from combustion heat in a steam generator	Distribution of liquid fuels via gasoline, fuel oil system; transmission of electricity via the grid
Production of synthetic oil by pyrolysis of shale; refinement into various petroleum products **	Transport of liquid fuels to conversion and end-use sites	Direct combustion of fuels for heating, vehicles, etc.; or production of steam for electricity generation	Transmission of electricity via the grid, or liquid fuels distributed by commercial networks
Production of bitumen (tar) from sand via several alternate processes; refinement of tar into various petroleum products **	Transport of petroleum products (gas and liquid) to conversion or end-use sites	Direct combustion of fuels for heating, vehicles, etc.; or production of steam for electricity generation	Transmission of electricity via the grid, or liquid fuels distributed by commercial networks
NA	NA	NA	Delivery of heat in fluid to space, or direct heating of space by sunlight
NA	NA	Electricity generation from steam	Transmission of electricity via the grid
Manufacture of solar cells **	NA	NA	Commercial distribution and sales of solar cells for direct energy production at end-use sites

(Figure 7 continued from page 103)

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DELIVERY STAGE ENERGY RESOURCE	EXPLORATION	EXTRACTION	TRANSPORT I
HYDROGEN FUEL	NA	Collection of water and other materials for hydrogen production from water	Pumping of water to dissociation site
WINDPOWER (SMALL SCALE)	Location of best wind collection areas	Erection of one or several small windmills to drive electrical generators	NA
WINDPOWER (LARGE SCALE)	Location and assessment of windy geographical areas	Construction of one or several windmills to drive electrical generators	NA
TIDAL POWER	Location and assessment of coastal areas with tidal power potential	Construction of generation stations to utilize tidal gradients	NA
OCEAN THERMAL	Location and assessment of ocean areas with adequate temperature gradients	Construction of generation stations in proper ocean areas	NA
GEOTHERMAL	Geologic location of geothermal areas and assessment of resource potential	Drilling and operation of geothermal wells	NA
BIOMASS	NA	Collection of combustible refuse from urban, industrial, or agricultural waste	Transport of wastes to conversion site
FUEL CELLS	Geologic location of necessary fuel cell component materials such as platinum, potassium, or nickel	Extraction of necessary minerals	Transport of materials to fuel cell assembly site

(Figure 7 continued)

PROCESSING	TRANSPORT II	CONVERSION	DISTRIBUTION
Dissociation of water into hydrogen and oxygen by electrolysis, bioconversion, or ultraviolet light **	NA	NA	Transport of hydrogen to end-use sites via pipeline, truck, or train
NA	NA	Operation of windmills	Connection to house or other end-use site electrical system and/or storage batteries
NA	NA	Operation of windmills	Transmission of electricity via the grid
NA	NA	Operation of generators	Transmission of electricity via the grid
NA	NA	Operation of generators	Transmission of electricity to shore, tapped into land grid
NA	NA	Production of electricity from geothermal steam, or steam produced from geothermal heat	Transmission of electricity via the grid, or distribution of geothermal steam by pipeline to direct space heating sites
Production of methanol by distillation or direct combustion of refuse •	Transport of methanol to end-use or conversion sites	Combustion of refuse or methanol to produce steam for electricity or for direct space heat	Transmission of electricity via the grid, or liquid fuels distributed by commercial networks
Assembly of fuel cells from constituent parts •	NA	NA	Commercial distribution of fuel cells to end-use sites

(Figure 7 continued)

RESOURCE	ORIGINAL ENERGY QUALITY OF RESOURCE	STAGES OF POTENTIAL ENERGY LOSS -- TYPE OF ENERGY LOSS AT THIS STAGE	USES	STAGES OF POTENTIAL RECYCLING OR CONSERVATION
SURFACE COAL	high original quality--concentrated energy potential	extraction--incomplete extraction or spillage transport --spillage processing--waste heat, incomplete cleaning for processing conversion--waste heat, low BTU gas waste, waste steam	electricity, coal, gas	transport--slurry processing--solvent refining conversion--low BTU gas for nearby electric plants

SECTION 4

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SECTION 4

DIMENSIONS OF ENERGY POLICY MAKING

After completing Section 4, you will:

(g) Understand current bases for energy policy decisions and their limitations.

(h) Understand criteria for a holistic approach to energy policy decision making

It is important to examine energy resource delivery and use with a systemic approach that uses the concepts and principles outlined in previous sections. However, there are many more considerations to the problems of energy delivery policies than simply the availability of resources and technical efficiency. We need to examine not only the stages of delivery in terms of energy considerations and efficiency, but we also need to explore energy policy in terms of environmental impact, political and social implications, economics, and regulatory constraints.

In any discussion of what constitutes energy policy or what processes create any policy, it is important to have before us a general definition of some important concepts. This is especially true in the area of energy policy, which is composed of highly interrelated elements from many areas involving interests from many diverse groups and often placing constraints on the activities of these groups. A good overall definition of policy as it relates to energy issues should include all these areas of interest. For our purposes, then, we can define the following:

POLICY

Policy is a set of guidelines for human behavior. These guidelines can be explicit, such as is found in legislation, executive edicts or administrative rule, regulations, or procedures. These guidelines may also be implicit, such as custom or behavior which has evolved historically into established patterns. The functions of policy are to permit, regulate, or inhibit human behavior. Policy making is the process of creating, adopting or changing policies.[1]

POLICY MAKING

It is necessary to elaborate on this concept and also distinguish between political and legal activities when we examine energy policy questions. As we will refer to them

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[1] Adapted from Duga, Jules J., David W. Malone, and Richard M. Davis. Energy: The Policy Planning Framework for State Governments, Vol. 2. Columbus, Ohio: Battelle Laboratories, April 30, 1976.

POLITICAL ACTIVITIES

LEGAL ACTIVITIES

here, *political* activities in terms of energy can be understood as those aspects of policy decisions which are negotiable. They often provoke controversy or stimulate debate and resistence to change. *Legal* action involves the implementation of legislation, and deals in the associated problems and constraints of regulation and compliance with the negotiated policy.

a. Energy Policy Goals

The character of a society is very much influenced by the nature of fuel availability and energy distribution. When we make decisions regarding any current or proposed energy policy, we must take into consideration the minimum ideal status of our own culture. This status is built of societal goals which may or may not be satisfactory to all individuals or groups. Steinhart suggests the following:

SOCIETAL GOALS

> Goals for the United States
>
> Below are what we consider to be the minimum societal goals that must be served by any energy policy. Because the purpose here is to find out about energy limitations, if any, and about needed policy and institutional changes, we will exclude matters which do not place demands on energy resources, even though we may feel strongly about society's need to change. These minimum goals are: (1) adequate food, clothing, and shelter for all; (2) opportunity to share in whatever surplus goods and services remain after basic needs have been satisfied; (3) ample employment or other meaningful activity for each person; (4) freedom to practice any lifestyle, subject only to the constraints of the above goals.[2]

Energy is a means to these social ends. The amount of energy we use to satisfy or accomplish general and specific social goals is often with a view to overcoming obstacles rather than a measure of ease or success. For example, our dependence on automobiles to get us easily further and faster calls for ever-increasing amounts of energy

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[2] Steinhart and Steinhart, p. 273.

to find and extract resources that in turn produce the energy to get us there. Different energy resource delivery means affect different segments of society to varying degrees. These social effects stem from the manner in which an energy policy answers these questions:

- whether energy use needs to grow;
- if so, how fast; and,
- how much energy a society will require to sustain particular life-styles.

ENERGY POLICY GOALS

In answering these questions, an energy policy can address the following major energy policy goals.[3]

(1) efficient economic and energetic use of nonconventional energy resources;

(2) low cost and abundant supply to consumers;

(3) protection from supply interruption;

(4) conservation of the environment;

(5) minimizing the depletion of domestic resources; and,

(6) limiting the impact on federal, state, and local budgets.

Some conflicts among these goals are immediately obvious. For example, low cost energy encourages increased use, which in turn often generates increased pollution. Protecting the environment through strong regulations on air quality, strip mining, and nuclear plant construction and waste removal raises the economic costs of energy to the consumer. The efficient use of nonconventional energy resources, require modifying or creating regulations which currently hold down the price of natural gas and domestic petroleum, and might affect both the rate of inflation and employment. It is likely that tradeoffs must be made among energy policy objectives in order to optimize societal goals.

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[3] Expanded from Congressional Budget Office, Energy Policy Alternatives, Budget Issue Paper, Washington, D.C., January, 1977.

In evaluating energy policy's effects on society, then, we must first examine different views regarding the relationships between energy, technologies, and public access to energy delivery and evaluation processes. It becomes important to examine the effects of any particular delivery system on different socioeconomic and ethnic groups, on employment patterns, education, and on geopolitical structures.

b. The Bases for Current Energy Policy Decisions

Our worldview, or perceptions of reality, directs our activities and usually becomes the central focus for policy decisions rather than physical and behavioral reality, which can be measured and observed scientifically. In previous sections, we have seen how a prevalent industrial worldview shaped our energy practices for a considerable time.

The limitations and shortcomings of this approach to energy policy have resulted in intensive U.S. energy development that relies primarily on a short-term outlook. Our dependence and consumption of massive resources has become so extensive that most Americans cannot conceive of operating on as little as one third of the energy we currently use, yet equally (if not more) civilized nations do so, such as France, Switzerland, New Zealand, and Japan.[4]

"TECHNICISM"

According to the views of one group of technology and energy analysts, we have become a "technicist" society.[5] In other words, we have let the technology of energy dictate our purposes or goals rather than using energy as a tool to achieve goals which we have set ourselves--the means have become the ends. An example would be the shift in transportation goals from acquiring easy physical access to acquiring new automobiles.

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[4] Bender, Sharing Smaller Pies, p. 6.

[5] Stanley, Manfred, "Technology and Its Critics," A Final Review: Harvard University Program on Technology and Society, 1972, pp. 20-21.

Illich conveys the idea that, in our culture, we have become, literally, energy addicts:

> ...the use of energy on a massive scale acts on society like a drug that is physically harmless but psychically enslaving. A community can choose between Methadone and 'cold turkey'--between maintaining its addiction to alien energy and kicking it in painful cramps--but no society can have a population that is at once autonomously active and hooked on progressively larger numbers of energy slaves.[6]

An important manifestation of the industrial worldview or approach to policy is the notion of the "technical fix." This notion is viewed on at least two scales. We mention two extremes, where one necessarily implies the other. Hardin states this notion as follows:

> An implicit and almost universal assumption...is that the problem under discussion has a technical solution. A technical solution may be defined as one that requires a change only in the techniques of the (natural) sciences, demanding little or no change in human values or ideas...[7]

"Technical fix," then, refers to (1) the assumption in Western culture that solutions to energy problems (ends) necessarily involve technology in the first place (means), and (2) the remedy which is based on this assumption will continually "fix" an energy problem rather than evolve new goals (ends) to solve (which would create new means). For example, simply buying an automobile that runs on unleaded gasoline (which may help lessen pollution), does nothing to help change the consumption of petroleum-based fuels. However, many observers realize that the "technical fix" will probably be useful as a conservation and transition tool while goals and values are undergoing change and new policies are being formulated.[8]

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[6] Illich, Ivan. Energy and Equity. New York: Perennial Libary, Harper and Row Publishers, 1974, p. 6.

[7] Hardin, Garrett, as quoted in "Philosophical Conflict: Re-examining the Goals of Knowledge," Hazel Henderson. Public Administration Review, January, 1975.

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[8] Schipper, Lee. "Explaining Energy: A Manual of Non-Style for the Outsider Who Wants In!", Middle and Long Term Energy Policies and Alternatives, Part 1. Washington, D.C., 1976. Appendix. pp. 556-557.

c. Conflicts and Constraints in Policy Making

Each of the parties interested in energy policy has its own priorities and needs. Their interests often conflict--the private interests of the energy companies and the broader public interest do not always coincide. Energy policy making confronts these conflicting interests in a variety of ways.

INTERESTED GROUPS

The major groups with vested interests in energy policy are:

> industry, the energy-consuming public, the government, the electric utility industry, and fuel-producing foreign nations.[9]

In the formation of energy policies, expert scientists and technicians can provide information and guidance, but they cannot provide the arbitration of these conflicts. The final decisions on energy related issues are based on value judgements. In the case of conflict, the public, usually through elected representatives and initiative, has the responsibility to determine which values are the most important. There are problems inherent in this ideal process, however, which stem from the fact that, in a electoral decision, the public can only vote on those options which are presented.

Government energy policy depends partly on history, partly on the relative strengths of the interested groups, partly on public opinion, and partly on perceived options.

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[9] Steinhart and Steinhart, pp. 285-290.

At present, policy is usually made for short- or middle-term goals. Steinhart lists the following long-standing policy directions which largely effect the government's reaction to energy issues:[10]

CURRENT POLICY DIRECTIONS

- Pursuit of continue exponential growth in the economy, which means that government currently seeks to maintain a fixed percentage growth rate;
- Commitment to nuclear energy, which stems from early successes with nuclear weapons technology and has produced a well-established nuclear power bureaucracy. These vested interests will probably defend the priority of a nuclear future against all alternatives;
- Fears for national security, intensified by the use of fuel supplies as a policy threat by the Arab nations, and resulting in policy pressure for national self-sufficiency; and,
- A past and current record of preferences and trust in technological and scientific rather than institutional or social solutions to energy problems, the policy manifestation of our "technicist" society.

ECONOMICS

The economics of energy delivery is another hotly debated area of energy policy. Due to the capital financial structure of this and other industrialized nations, and well-infused assumptions about the nature of economic growth, economics usually forms the basic (often the only) technique for analyzing and evaluating existing or proposed delivery systems.

The price that is paid for energy influences, to a great degree, the amount of a resource that is discovered and used.[11] Rising prices often lead to the substitution of one fuel for another as new sources or methods become more "economic." Higher prices often lead to more exploration and discovery. However, we can see that, when we are dealing with finite reserves, this economic growth model cannot hold for the long-range.

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[10] Ibid, p. 287.

[11] For a discussion on some specific energy/economic relationships, see Energy Policy Project of the Ford Foundation, A Time to Choose, Cambridge, Mass.: Ballinger Pub. Co., 1974, pp. 7-8.

INSTITUTIONAL BARRIERS

Finally, solutions to conflicts are constrained by the institutions we have built to deal with policy. "Every institution in our society is organized to encourage and further growth, and every institution has developed patterns of organization and operation that require unaffordable quantities of our resources and wealth."[12] For example, tax laws stimulate growth of corporations at the expense of individuals and small businesses. Urban growth demands large rates of consumption, and we often try to dump the resultant pollutants on unprotected ecosystems. And, under the protection of the right to free speech, we are assaulted with private advertisements for furthering consumption and energy use. The time lags between decisions about these or other issues and ongoing operations can create hardships for all the conflicting groups.

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[12] Bender, p. 7.

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d. A Holistic Approach to Energy Policy Making

It would not do to simply decry current trends in energy policy without offering some image of an alternative approach. With our understanding of an emerging Stewardship Worldview, we can characterize the important components of this holistic approach to policy making. These components are:

(1) the role of economics;
(2) the notion of appropriate technologies;
(3) the role of government and utilities; and,
(4) the role of citizens.

(1) The Role of Economics

"Economics may be the most important force in determining how man uses energy, but it is always the laws of physics and technology which determine what _may_ or _may not_ happen."[13] It is possible to use economics in an integrative fashion. We can examine the structure of the total economy in terms of the output in energy and materials from both energy-intensive and nonenergy intensive sectors. We can also examine the structure of the _energy economy_, i.e., the efficiency of the fuels used and the ways they are used. These economic considerations can be combined to give us an image of economic growth in relation to energy use.

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[13] _Appendix to Hearings before the Subcommittee on Energy and Power_ Part 1: Middle- and Long-Term Energy Policies and Alternatives, Washington, D.C.: U.S. Government Printing Office, 1976. Appendix: "EXPLAINING ENERGY: A Manual of Non-Style for the Energy Outsider Who Wants In!" Lee Schipper, p. 492.

Following is a list of some basic issues of energy economics to consider in energy policy decisions:[14]

- "Incentives" needed to encourage energy recovery and development;
- Competition and structure in the "energy industries;"
- Government role in regulation and subsidy;
- Integrated ownership or organization of energy facilities:

  vertical integration: where one company owns or controls a fuel from extraction to retail sale; or,

  horizontal integration: diversification, where a company controls significant activities in competing fuel industries, for instance, uranium and coal as well as oil;
- The "free market," what it is in theory and practice, and its role in the allocation of energy resources and patterns of energy use;
- Effects of government or private policies regarding taxes, depletion allowances (tax breaks for fuels actually extracted and sold), import/export quotas, indirect costs and "externalities," subsidies, etc.;
- Effects of physical constraints and resource availability on costs, competition, and the market; and,
- Advertising and promotion of energy use.

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[14] Adapted from Schipper, Appendix to Hearings Part 1, p. 507.

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(2) The Notion of Appropriate Technology

Amory Lovins introduces the idea of the "soft energy path" as one way to define the role of technology in developing a stewardship-based energy policy. A

"SOFT PATH"

"soft path" is characterized by greatly increased efficiency in using energy, a rapid deployment of "soft" technologies and the transitional use of fossil fuels as a brief bridge to an energy efficient economy.

"SOFT TECHNOLOGIES"

"Soft technologies" are defined as follows:[15]

- They are diverse: the soft energy component of an energy supply is made up of many small contributions by diverse technologies, each designed for what it does best in particular circumstances;
- They operate on renewable energy flows: the soft technologies use sun, wind, forestry, or agriculture, rather than depletable fuels;
- They are relatively simple and flexible: a soft technology may be highly sophisticated, like a pocket calculator, but it is easily understood and accessible;
- They are matched in scale and in geographic distribution to the end use needs: a soft technology takes advantage of the distribution patterns of natural energy flows; and,
- They are matched in energy quality to end use needs.

APPROPRIATE TECHNOLOGY

The concept of appropriate technology is an elaboration of this role of soft technology and provides a direction for the "technical fix." What is necessary is for us to replace our present technology with one which is appropriate to the energing worldview and new environmental conditions. Appropriate technology becomes broader than the questions of machines and tools, but includes the nature of all the organizational, conceptual, political, physical, and spiritual tools brought into play by our activities.

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[15] Lovins, Soft Energy Paths, pp. 38-39.

According to Tom Bender, an appropriate technology would:

- Provide full employment and meaningful work.
- Substitute human resources for energy and material ones. For example, labor-human involvement rather than dependence on machines.
- Operate capably within the levels and patterns of activities sustainable with renewable energy sources and material recycling.
- Promote equity, independence, soundness, stability, and other values appropriate to a sound and enduring society.
- Be easily applicable on a broad scale and to both urban and rural areas.
- Be affordable in terms of money, energy, materials, and human, environmental, and social costs.
- Establish a self-sustaining and expanding reservoir of skills and self-confidence.
- Permit easy control of political, economic, and social systems.
- Establish a small enough scale of operations to permit and contribute to social, economic, and environmental diversity, stability, and control.
- Provide the best possible support for not only our material comfort, but our psychological, cultural, and spiritual growth as well.
- Reduce economic, social, and political dependency between individuals, between regions, and between nations.
- Permit ownership of the means of production by those who do the work.[16]

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[16] Bender, pp. 20-21.

(3) The Role of Government and Utilities

The government has a primary responsibility for stewardship, most importantly for the natural ecosystems that support the satisfaction of the public's human needs. It is this sector of society that can protect future citizens from loss of resources due to exploitation by present citizens and industries. The government's major responsibility in this area is to prevent the degradation of these natural system supports, maintain their dynamic capacities, and when possible, to extend natural resource capabilities in terms of quality as well as quantity. Those governments of the past and present and those who have profited from their actions, must be accountable to present and future inhabitants and to the natural ecosystems of which they are a part.

ROLE OF GOVERNMENT

To evaluate the role of government in any particular energy decision, it is wise to examine the current role of different levels of government in similar situations. It is not hard to trace the counterproductive manner in which some regulations and policies actually work in a multilevel administrative structure.

To evolve a comprehensive energy policy and create regulatory administrations through all relevant governmental levels, inter- and intra-agency responsibilities were organized...with mandated obligations to regulate specific flows and storages of energy, materials, and money.

Investigations into their functioning will help determine the necessity for centralized or decentralized governmental controls for different operations.

Questions involving centralized or decentralized controls directly connect with the physical arrangements of the delivery system. For example, if smaller, local plants are required for generating electricity, central control is often too far away to be effective in immediate operations. Rather, it is useful to have local, or decentralized control which can be accountable to the immediate community. A central information bank or clearinghouse, however, remains useful as a storage and retrieval base for information about local operations.

CENTRALIZED CONTROL

DECENTRALIZED CONTROL

At this point it becomes necessary to define the manner in which utilities function in energy policy making. Questions involving the role of utilities fall under three broad categories:

ROLE OF UTILITIES

- questions about ownership;
- questions about control and accountability; and,
- questions about financing.

Ownership considerations include decisions as to public or private ownership of utilities. These lead to the next set of questions about control and accountability. For example, if a utility is publicly owned, how is it controlled, and by whom?

The financing aspects of energy policy making are complex. An incredible amount of government investments, subsidies, tax credits, and other incentives encourage the development of new energy supplies and centralized delivery systems. Often new regulations are relaxed where they conflict with existing or previously proposed explorations for raw materials or subsidized experiments and developments.

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(4) The Role of Citizens

The energy-consuming public is one of the major interest groups in energy policy decisions. As an aggregate citizenry, we have under our direct control the two largest end uses of energy--the automobile and home heating.[17] Because of this, the first two federal policies for energy conservation were directed toward these two uses.

Grass roots expression on energy related issues has resulted in legislation mainly in the area of environmental protection. A stewardship-conscious citizenry should ensure that environmental gains are not prioritized over shortages in necessary energy for satisfaction of human needs. The public must be aware that issues such as highways, mass transit, zoning and building codes, personal lifestyles, and public expenditures on research and development determine the future of energy supplies and quality of life.

An environmentally aware citizenry can actively take part in energy issues, not only by individual and community conservation practices, or voting and writing letters, but by attending the public hearings determining local and national energy pricing, and filing written comments on environmental impact statements. Some citizens may think that these types of activities are ineffectual, but they have the composite force of which we spoke earlier. Energy companies spend millions of dollars in advertising campaigns to influence public opinion, realizing the potential of the public force that influenced Congressional interest at the time of the Arab oil embargo.

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[17] Steinhart and Steinhart, p. 286.

ACTIVITIES

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FACILITATING NOTES

The concepts in this Section are integral to the completion of the final INTERGRATION Activity. Be sure that your group understands the important considerations for a holistic approach to energy policy making.

Refer as much as possible to the readings and module text to help clarify aspects of these concepts.

ACTIVITY I

1. An example chart answer (#4) is provided as a reference for the brief manner in which you can fill out the matrix.
2. Suggestions for the possible scope of the discussions can be found on page 260.
3. Teachers are encouraged to draw on examples from their own experiences, and their knowledge of current energy policy issues as related to the discussion.

ACTIVITY II

1. An example chart answer is provided as a reference for the manner in which you can fill in the matrix. The answers here should be somewhat more extensive than in the previous chart exercises.
2. Suggestions for the possible scope of this discussion (#2) can be found on page 260.
3. Similarly to #1, an example chart answer is provided. Also, similarly to #1, the answers here should be more extensive than in previous exercises.

OBJECTIVE: (g) Understand the current bases for energy policy decisions and their limitations.

READING: Steinhart, Carol and John. Energy: Sources, Use, and Role in Human Affairs. Duxbury Press, 1974. pp. 274-290.

TO DO: 1. Each teacher summarizes the major points of the American Petroleum Institute's policy recommendations by filling in the chart below. One example is provided.

API RECOMMENDATION CATEGORY	MAJOR PRIORITIES FOR ENERGY POLICY
(1) Exploration and development	
(2) Taxation and regulation	
(3) Import policy	
(4) Synthetic fuels	move government (taxpayer) support for research; more support from tax subsidies.
(5) Environmental protection	
(6) Coordination of federal energy programs	

2. Discuss how (or if) these policy recommendations address any or all of the energy policy goals listed below (from p. 115 in this Section):

    - efficient economic and energetic use of non-conventional energy resources
    - low cost and abundant supply to consumers
    - protection from supply interruption
    - conservation of the environment
    - minimizing the depletion of domestic resources
    - limiting the impact on federal, State, and local budgets.

3. As a group, discuss the relationships between these policy recommendations and the current policy directions discussed on pp. 121 of this Section:

    - pursuit of continued exponential growth in the economy
    - commitment to nuclear energy
    - fears for national security
    - technological solutions to energy problems

4. Discuss the roles of the "interested parties" in energy policy:

    - industry
    - the energy-consuming public
    - the government
    - the electric utility industry
    - fuel-producing foreign nations

    In what ways are these interests affected by energy policy?

    How could or do these interests influence energy policy?

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OBJECTIVE: (h) Understand criteria for a holistic approach to energy policy decision making.

TO DO: Following these directions is an excerpt from the report, Energy: The Policy Planning Framework in State Governments.[18] This excerpt is a discussion of the energy policy direction for the State of Texas, with an additional table which summarizes the status of energy policy areas in Texas. All teachers read this summary and complete the following exercises.

1. Each teacher fill in the chart below in terms of how (or if) the energy policy addresses any or all of the energy policy goals from p. 115 of this section. As a group, discuss the reasons for your answers. One example is provided.

ENERGY POLICY GOAL	HOW ADDRESSED IN TEXAS ENERGY POLICY
Efficient economic and energetic use of non-conventional energy resources	Significant increments in energy supply expected from government-funded research in solar, liquite gasification and geothermal energy; localized benefits from wind, ocean energy and solid waste treatment.
Lost cost and abundant supply to consumers	
Protection from supply interruption	
Conservation of the environment	
Minimizing depletion of domestic (Texas) resources	
Limiting impact on State budget	

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[18] Dugas, Jules, et al. Energy: The Policy Planning Framework in State Governments. Columbus, Ohio: Battelle Laboratories, April 30, 1976. Vol. 1, p. 21; Vol. 2, pp. C-19 to C-26.

2. Discuss the relationships between the energy policy and the current policy directions listed on pp. 121.

3. Each teacher fill in the chart below in terms of how (or if) the Texas energy policy addresses the holistic energy policy components from p. 123 in this section. As a group, discuss the reasons for your answers. One example is provided.

HOLISTIC ENERGY POLICY COMPONENTS	HOW ADDRESSED IN TEXAS ENERGY POLICY
(1) Role of economics	
(2) Notion of appropriate technology	
(3) Role of government and utilities	Government regulated conservation measures; legislative action in utilities regulation; Geothermal Production; Energy Efficiency Labeling; Mass Transit; Energy Conservation in Buildings; Government Energy Council research.
(4) Role of citizens	

SUMMARY OF THE TEXAS ENERGY MODEL PROJECT

Objectives

The Governor's Energy Advisory Council was charged by the Governor of Texas with developing an energy policy for the State of Texas. After deliberation, the Council articulated the objectives of their work as follows:

- Develop a public policy document for energy production, distribution, and use for the State of Texas
- Evolve specific legislation recommendations to implement this policy
- Evolve a program of energy-related research
- Evolve a program of public assessment related to the energy actions of the State.

In addition, the Council was charged with recommending a longer term organizational structure by which the State could continue to deal with public policy questions and problems related to energy.

Research Philosophy

The purpose of the Texas Energy Scenarios was to illustrate the trends that might be expected to result in Texas as a consequence of various types of policy being followed. None of the four scenarios was considered to be a forecast of the actual future. The purpose of the scenarios was to help the policymakers in deciding on the best balance of measures. The Council's philosophy was summarized in one of their documents as follows:

> "....We have not presumed to decide for the citizens of Texas if they want a high, low, or intermediate economic growth rate for the State, or the nature of their lifestyle or environment. It is our objective in this report to present the best available thinking on the effects of various energy policies subject to the constraints of national policy and available resources. The people of

Texas, through their elected representatives, will make the choice of which policy mix is acceptable."*

Organizational Structure

During the spring of 1973, the Texas Legislature passed a resolution requesting the Governor to form an energy advisory council to be charged with the goal of recommending a State energy policy. The Lieutenant Governor was appointed as Chairman of the Council. The Governor's Energy Advisory Council is comprised of 34 members representing a broad range of interests and including:

- Seven key elected officials of the State: Lieutenant Governor, Attorney General, Railroad Commissioner, Agriculture Commissioner, Land Commissioner, Chairman of the House Energy Committee, and Chairman of the Senate Natural Resources Committee
- Ten appointed officials whose work is related to energy policy
- Five individuals from universities and public interest groups
- Twelve individuals from various segments of industry.

In order to carry out its work, the Council organized four committees to supervise the research in (1) supply and demand, (2) environmental and social aspects, (3) legal and regulatory policy, and (4) new technology. In turn, each of these committees arranged for various universities and research organizations to carry out specified energy research.

The Texas program of energy research, assessment, and policy planning consists of two basic parts:**

(1) A Four Program Core study consisting of 37 projects

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* Finch, R.D., and Harriet Hahn, Texas Energy Scenarios, Special Project F, The State of Texas, Governor's Energy Advisory Council, p 6, January, 1975.

** The individual Texas projects are listed in Appendix D.

(2) Three Coordinated Projects each of somewhat larger scope than the projects in (1) above; each carried out by a university team with demonstrated expertise in its own subject area.

Figures C-2 and C-3 show the schematic outline of the overall program. The overall program has been designed to produce the information on which to base public policy decisions, legislative recommendations, and recommendations for a research program for the State.

It should be noted that this program involves active participation of individuals from five major universities in the State (and over 15 departments), from eight State agencies, and five industry trade organizations and companies. This direct project involvement is in addition to the work of the individual members of the Council.

Structure of Texas Energy Program

Figure C-4 indicates the flow chart for the formulation of energy policy recommendations by the Governor's Energy Advisory Council. This chart shows the relationship between the various activities of the Council and its contractors to the final policy recommendations.

The methodology followed in preparing the Texas energy scenarios is illustrated in Figure C-5. First, the assumptions of each scenario were set down in detail. The economic consequence of these assumptions were then evaluated using the computerized input/output model of the Texas economy maintained by the Office of Information Services (OIS) in the Office of the Governor. The OIS model is normally used for short-term predictions, for which it is reasonable to assume that the transactions between sectors of the economy will continue in the same way as in the past. However, in order to account for rapid economic adjustments the assumptions of the OIS model had to be changed. A separate study project, S/D-4, was undertaken to determine: (1) how producers of oil and gas might increase production in response to higher prices, (2) how cost conscious users of oil and gas might decrease their demand in response to higher prices or substitute other fuels, and (3) how these producer and user responses would affect the national market prices of oil and gas.

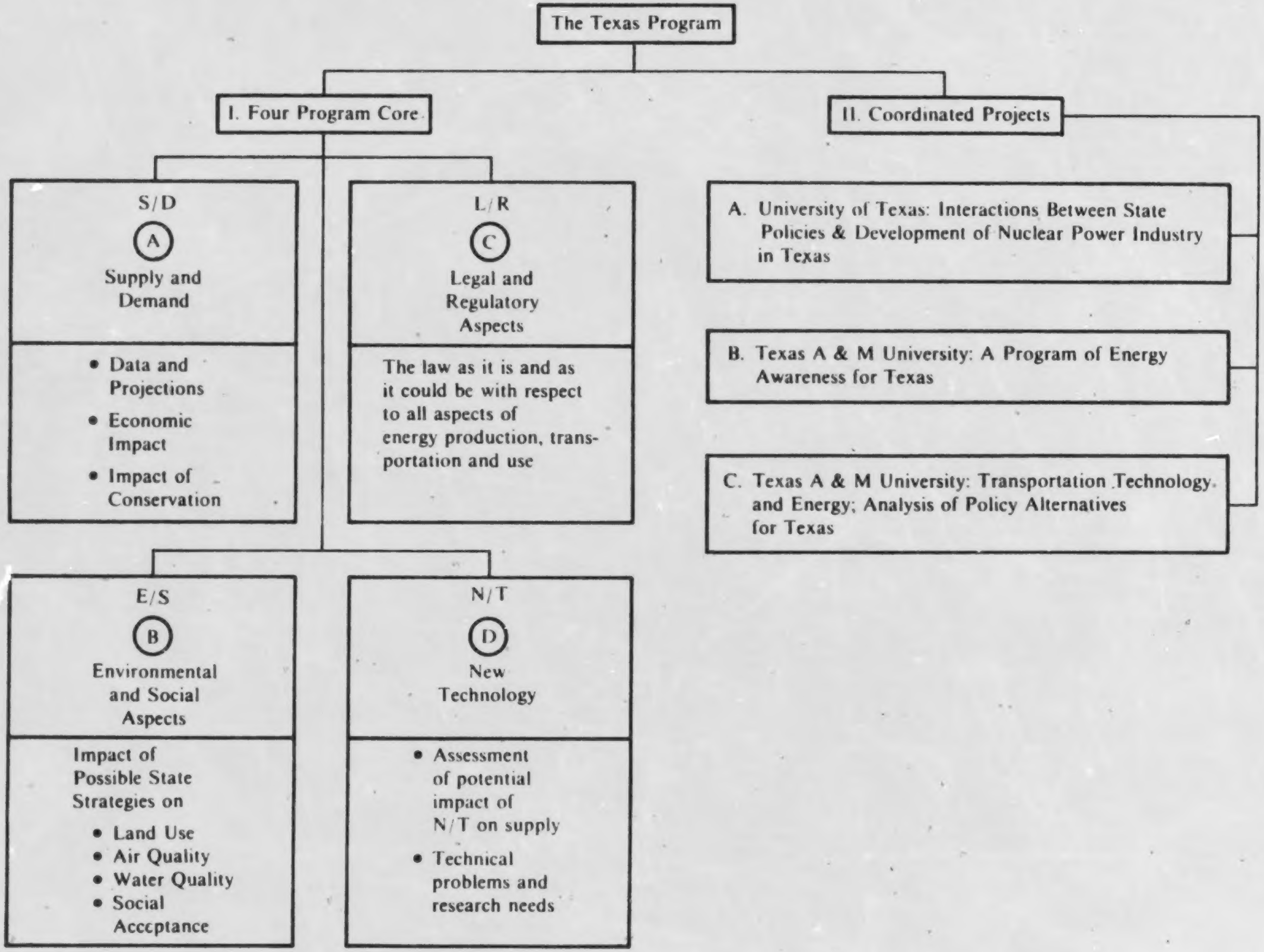
The Texas Program
I. Four Program Core
II. Coordinated Projects
S/D
A
Supply and Demand
• Data and Projections
• Economic Impact
• Impact of Conservation
L/R
C
Legal and Regulatory Aspects
The law as it is and as it could be with respect to all aspects of energy production, transportation and use
E/S
B
Environmental and Social Aspects
Impact of Possible State Strategies on
• Land Use
• Air Quality
• Water Quality
• Social Acceptance
N/T
D
New Technology
• Assessment of potential impact of N/T on supply
• Technical problems and research needs
A. University of Texas: Interactions Between State Policies & Development of Nuclear Power Industry in Texas
B. Texas A & M University: A Program of Energy Awareness for Texas
C. Texas A & M University: Transportation Technology and Energy; Analysis of Policy Alternatives for Texas

Figure C-2. The Texas Governor's Energy Council Program

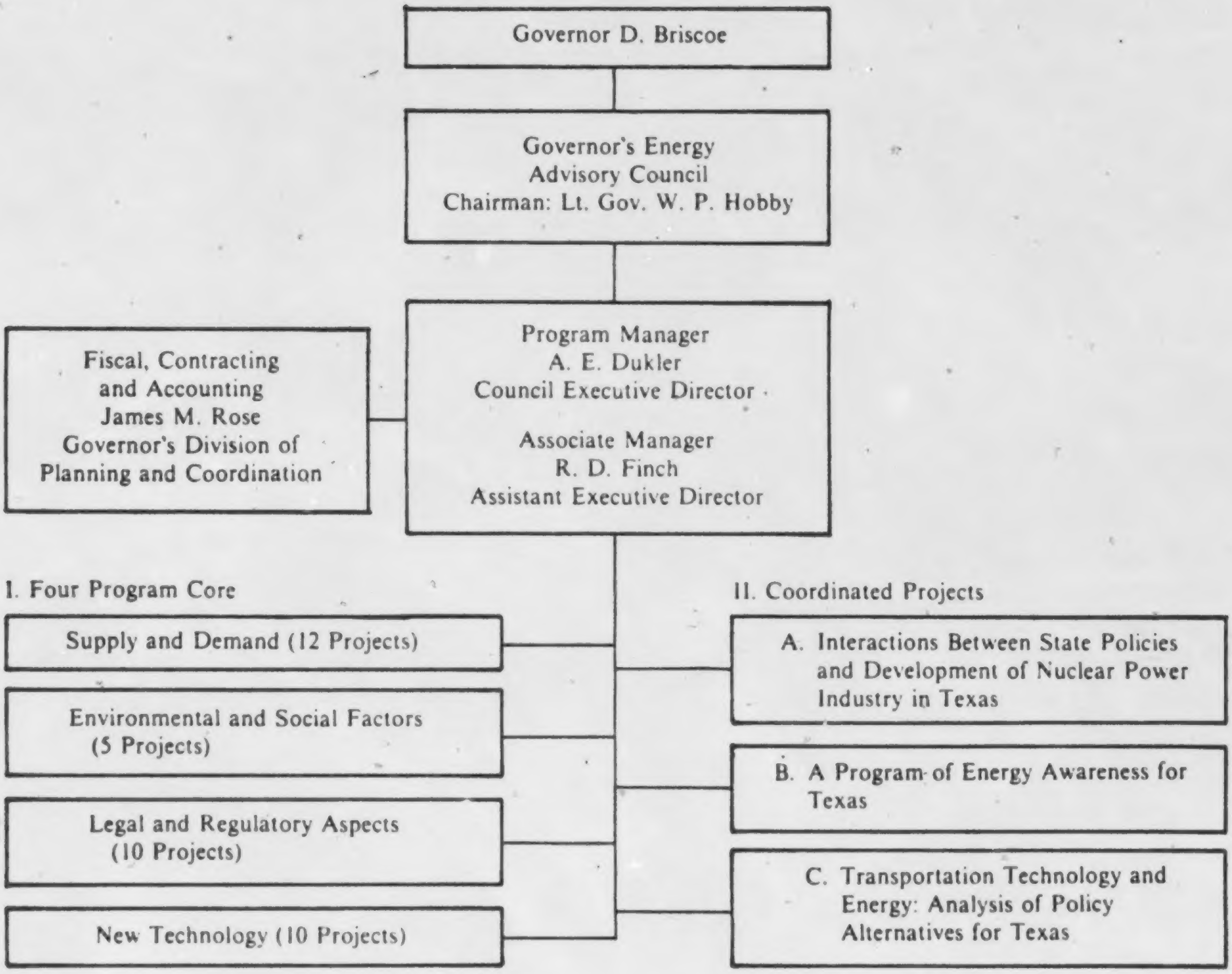
Governor D. Briscoe
Governor's Energy Advisory Council
Chairman: Lt. Gov. W. P. Hobby
Fiscal, Contracting and Accounting
James M. Rose
Governor's Division of Planning and Coordination
Program Manager
A. E. Dukler
Council Executive Director
Associate Manager
R. D. Finch
Assistant Executive Director
I. Four Program Core
Supply and Demand (12 Projects)
Environmental and Social Factors (5 Projects)
Legal and Regulatory Aspects (10 Projects)
New Technology (10 Projects)
II. Coordinated Projects
A. Interactions Between State Policies and Development of Nuclear Power Industry in Texas
B. A Program of Energy Awareness for Texas
C. Transportation Technology and Energy: Analysis of Policy Alternatives for Texas

Figure C-3. Program Management

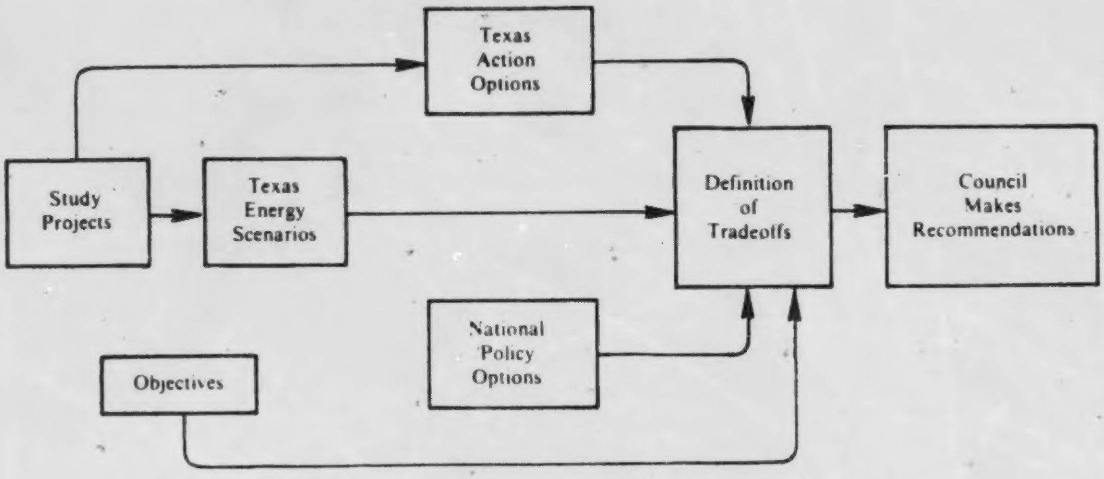

Figure C-4. Flow Chart for Formulation of Texas Energy Recommendations

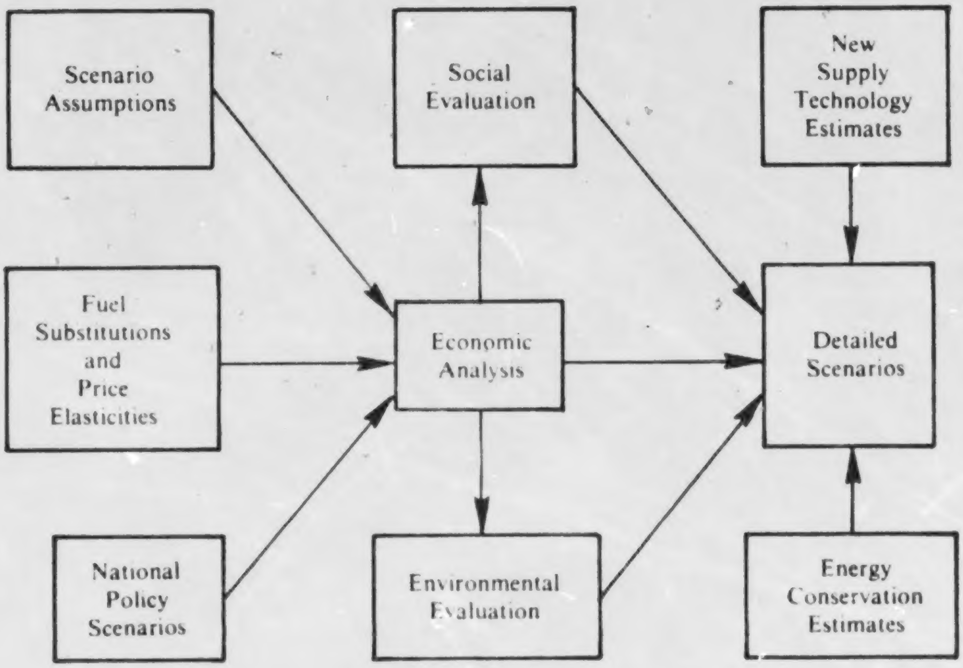

Figure C-5. Relationship of State Energy Scenario Project to Other Council Activities

The scenario assumptions and economic evaluations were reviewed by the investigators of the projects on air and water pollution and land use (projects E/S-1 through E/S-4). Similarly, the scenario assumptions and economic evaluations were reviewed by the sociologists involved with project E/S-5 to predict the effects of the various policies on individual people.

Estimates of energy savings that might be possible as a result of government-regulated conservation measures were made by investigators of projects concerned with energy use in the residential and commercial sector, in industry and agriculture, and in transportation. The Market Forces Scenario indicated that increased use of enhanced recovery of oil and gas, nuclear energy, and coal probably will result from this policy. Estimates of potential increases in supply over and above those to be expected from the operation of Market Forces were made by investigators in the New Technology Program. Significant increments in the State's energy supply can be expected from government-funded research and development in solar, nuclear, in-situ lignite gasification, and geothermal energy. Lesser and more localized benefits are anticipated from wind and ocean energy and solid waste treatment.

The Texas program was significant for both the structure of the overall effort and the substance of the individual projects. From a structural point of view, this undertaking provided an example of how diverse and independent institutions within the State could be focused on a single problem area of major importance. Secondly, the technical aspects of the problem were considered as separable isolated entities, with each project being specifically defined to provide directed research toward individual elements of the core questions. Through an organization of the output and a definition of limitations, it is felt that the Texas program has served to provide the State with clear answers as to what their options and futures are.

In terms of specific output from the technical and organizational structures of the Texas program, there are certain "measurables" that lie in the area of policy applications. Many of these are reflected in the legislation that has been introduced and passed by the State Legislature, including Acts relating to Utilities Regulation, Geothermal Production, Energy Efficiency Labeling, Mass Transit, and Energy Conservation in Buildings. According to the Texas researchers, the definition of the provisions of these Acts was largely based upon the technical support provided through the policy-related research of the Governor's Energy Council. Other bills that were introduced to the Legislature (but not passed) related to Environment and Energy Procedures, Natural Gas Conservation, and an Energy Development Fund.

In addition, the Texas researchers felt that one of the more important outputs of their efforts was the definition of the futures that are available and the technical data that lead toward those futures. With particular regard to the potentials for new technology, there is confidence in the results that place upper bounds on the potentials for new energy resource development and the definition of the opportunities and constraints with which they are faced.

Table 2c. Status of Energy Policy Areas – Texas

	Texas		
Policy Area	**Responsibility**	**Status**	**Role of Analysis**
Electric Power Plant Siting	Legislature	Policy Exists – Environmental legislation applies. Power Plant Siting Committee prepared report in 1972; no legislative response to date.	Somewhat
Electric Power Pricing	Public Utilities Commission	Policy Exists – PUC created by recent legislation, primarily to provide information and counseling on request.	Somewhat
Natural Gas Supply/ Allocation	Texas Railroad Commission	Policies Exist – Priorities established.	Somewhat
Petroleum Supply/ Allocation	Texas Railroad Commission (Supply) Governor's Energy Advisory Council (Demand) Division of Planning Coordination (Allocation)	Policies Exist – Production policies have evolved over time. Federal guidelines followed for allocation.	Somewhat
Energy Conservation	Texas Railraod Commission Governor's Energy Advisory Council	Alternatives Being Identified – Communication and education emphasized, building codes being looked at.	Heavy
Energy Resource Development	Texas Railroad Commission	Alternatives Being Evaluated – New technologies bill failed recently, geothermal *in situ* gasification, and nuclear fusion being considered.	Heavy
Transportation	Dept. of Highways & Public Transportation	Implementation Pending – Recent legislation changed name and mission of Department of Transportation to focus more attention on rail systems, mass transit in major cities, etc.	Heavy

SECTION 5

RESOURCES

Armstrong, Joe E., and Harman, Willis W. *Strategies for Conducting Technology Assessment*, Department of Engineering-Economic Systems, Stanford University, December, 1977.

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Hetman, Francois. *Society and the Assessment of Technology*: Paris: Organization for Economic Co-Operation and Development, 1973.

Lovins, Amory B. *Soft Energy Paths*, San Francisco: Friends of the Earth International, 1977.

Miller, G. Tyler. *Living in the Environment*, Belmont, CA: Wadsworth Publishing Co., Inc., 1975. *Enrichment Study #10*: "Nuclear Energy Dilemma," *Enrichment Study #20*: "Some Energy Alternatives: Fusion, Solar, Geothermal, Wind and Conservation."

New Scientist, January 11, 1973. "Not Playing The Game."

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Scientific American. Energy and Power, San Francisco: W. H. Freeman and Co., 1971. Chapter 8.

Steinhart, Carol and John. Energy: Sources, Use and Role in Human Affairs. North Scituate, Mass.: Duxbury Press, 1974.

Tuve, George L. Energy, Environment, Populations, and Food, New York: Wiley-Interscience Publication/John Wiley and Sons, 1976.

SECTION 5

EVALUATING ENERGY RESOURCE DELIVERY

After completing Section 5, you will:

(i) Understand a holistic approach to technology assessment as a tool for influencing energy policy.

(j) Become familiar with holistic criteria for the assessment of selected energy resources.

Although it is almost redundant to restate that the sciences and technological advancements have contributed to the shaping of the kind of world in which we all live, the side effects of technological change have become important issues of public concern. The often unforeseen and most unwanted effects have become clearly evident. Some of these are directly observable, such as the obvious pollutions and general degradation of the environment. Others are more subtle and harder to measure, such as increasing dissatisfactions with education, business and government practices, and the general changes in overall "quality of life." Many of these are often directly attributed to "technology" itself, rather than to shifts in overall societal goals. In this section, we outline a holistic framework for evaluating energy delivery, to aid in making decisions about energy policy questions.

Earlier in this module, we examined the nature and delivery of energy resources to provide for current societal needs. We have discussed how energy policy decisions are constrained by the way interested parties view resources' developments and the importance of high energy use.

TECHNOLOGY ASSESSMENT

It becomes evident that some tool is needed to assist in the decision making process if the conflicting interests are to share some common ground. A specific kind of evaluation tool is becoming widely used to examine policy questions involving any kind of resource delivery process. This tool is technology assessment.

a. Limitations to the Current Use of Technology Assessment

The definitions of technology assessment vary from field to field, and from individual to individual, depending on what aspects are important to any particular group. For example, even among a variety of fields, very different activities are labeled by the same term. On-going project feasibility studies, analyses of resource allocation, cost-benefit analyses, and technological forecasting are often renamed "technology assessments."[1] This tends to restrict the definition to mean an essentially operational analysis of individual technologies discussed as concretely and specifically as possible. Examples of definitions of technology assessment can be found in a report conducted by Stanford University, 1977.[2]

Another type of limitation or constraint to the use of technology assessment stems not from its definition, but from its acceptance by different interest groups in policy decisions. Following is an example of the results of a technology assessment used for a simulated policy making situation:[3]

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[1] Hetman, Francois. Society and the Assessment of Technology. Paris: Organization for Economic Co-Operation and Development, 1973, p. 55.

[2] Armstrong, Joe E., and Harman, Willis W. Strategies for Conducting Technology Assessment. Department of Engineering-Economic Systems, Stanford University. December, 1977. Appendix A, pp. 138-139.

[3] From "Not Playing the Game," New Scientist, January 11, 1973.

> Computer games and models are touted as good ways to teach people about the counterintuitive behaviour of the real world. But the real world had best not be too counterintuitive. IBM last year stopped using one game because, according to its investor, "IBM said senior management felt the game attacked their value system."
>
> Players were divided into three teams--industry, social services, and urban life--and made investment and spending decisions for that sector. Each play had a computer terminal to record his decisions and to tell him how he was doing. The computer instantly calculated the social and economic effects of these decisions, and each player's decisions affected all other players.
>
> The unique aspect of the game, however, was that each player also had a computer controlled slide projector which showed slides illustrating the state of the player's "world"--slums and pollution if things were going wrong, happy people and green fields if things went well. The real goal of the game was to bring up pleasant pictures on your screen.
>
> Its failings at IBM may have been implicit in the model. Necessarily quite simple, the model had the difficulty that if an industrialist constantly reinvested all of his money, he quickly became very rich and nothing anyone did would change that. To keep the game balanced, an income maldistriubtion check was added--if there was too much of a difference between the richest and poorest players, the computer announced a revolution which redistributed wealth.
>
> Middle management enjoyed the game and had no trouble with it. But top management could not cope with the fact that seemingly reasonable business decisions had unacceptable political and environmental consequences. Rather than admit their preconceptions might be wrong, the game was scrapped.

The key to this conflict is the solution of the group of "top management": they scrapped the game as a decision-making tool. Yet this example gets to the core of why energy policy decisions should not be left only to those who input into decisions from only one viewpoint. What we have here is a question of societal values--whose are they, what sectors of the population do they represent, and how do energy policy decisions affect them?

b. The Potential for Holistic Technology Assessment

To help evaluate the broad range of issues in any energy policy question, we can expand the narrow view of technology assessment. With a systemic approach to the use of technology assessment, we can examine energy resource delivery systems from an integrative point of view. With this perspective, we will define holistic technology assessment in as broad a scope as possible:[4]

- Holistic technology assessment is a field of analysis that emphasizes the impacts of particular technologies on all perceivable aspects of society.

The following expanded definition is used by the Congressional Research Science of the American Library of Congress:

> "Technology assessment is the process of taking a purposeful look at the consequences of technological change. It includes the primary cost/benefit balance of short term localized market place economics but particularly goes beyond these to identify affected parties and unanticipated impacts in as broad and long range fashion as possible. It is neutral and objective, seeking to enrich the information for (management) decision. Both "good" and "bad" side effects are investigated since a missed opportunity for benefit may be detrimental to society just as is an unexpected hazard."[5]

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[4] Holistic in the environmental education sense means focusing on and attempting to clarify the relationships between natural and human systems by examining the components and reciprocal functions of both.

[5] Hetman, Francois, Society and the Assessment of Technology. Paris: Organization for Economic Co-Operation and Development, 1973, p. 57.

The Stanford study notes that all their examined definitions of technology assessment are based on two assumptions:[6]

- The implementation of new or expansion of an old technology is (or should be) a conscious societal choice; and
- Generally technology itself is not inherently harmful, but its management, and that management should be conducted for the long-range interest of society.

TECHNOLOGY MANAGEMENT

If we agree, then, that the basic problem is not technology but technology management, we can see that we are immediately confronted with value choices and decisions concerning societal goals.

Stanford also provided a summary of elements which appear to be central to most definitions of technology assessment and which outline some boundaries for the use of this tool:

- Technology can and should be consciously and rationally managed toward a goal contributing to the long-range benefit of mankind in general and organized society as we presently know it in particular. There is a concomitant adjunct that the management will be enhanced by a comprehensive and even-handed evaluation and comparison of the valid alternative choices available.
- Technology Assessment is intended primarily to provide assistance in making policy decisions and as such is expected to provide comparisons of the broad range of advantages and disadvantages to specified stakeholders of at least the most likely attainable alternatives presently available.

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[6] Armstrong and Harman, Stanford Study, p. 5.

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- Technology Assessment is inherently a multidisciplined effort requiring the active participation of social as well as physical scientists (and the public).

- Technology Assessment must include projections into the future and deliberately deal with the uncertainty inherent in such projections.

- The general term "technology" also includes "management or soft technologies" (sometimes termed social technology) as well as the usual connotation of physical technologies.

With this systemic holistic definition, we are able to include quantitative and qualitative information in evaluations of energy resource delivery systems. Technology assessment, in this sense, can be viewed as an "art," rather than a strict science, because of the subjective judgements that are necessary for evaluating such effects as psychological and social impacts.

c. An Assessment Framework

There are really only two inputs to industrialized societies: energy and materials. Many materials can be substituted for one another; for instance, often we can substitute aluminum for glass. Similarly, we can often substitute one fuel for another when we need energy. But energy cannot be substituted for materials; nor can materials be substituted for energy. This is why the supply and control of energy is vital for any industrialized society.[7] Our view of technology assessment requires that we consider emergent societal attitudes and new cultural views as a background to frame the manner in which we investigate the supply and control of energy.

Two basic types of technological innovation should be involved in the assessment of policy decisions. The first concerns the development of new energy technologies. The second involves the effects of currently operative energy technologies, especially those causing widely-felt problems.

In order to increase effective involvement in energy policy decisions, the actual assessment process should be simply outlined. Before we draw conclusions about any energy resource delivery technologies, we need to remind ourselves of the primary questions.[8]

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[7] Steinhart and Steinhart, p. 273.

[8] From Lovins, Soft Energy Paths, p. 7.

- Who is going to require the energy?
- How much energy?
- What kind of energy?
- For what purpose?
- For how long?

To answer these questions we need particular parameters of evaluation. Following is a discussion of criteria to help you understand the complexity of a comprehensive assessment. These criteria fall into three very broad categories. These categories encompass increasingly wide spheres of impact and evaluation:

ENERGY
SYSTEM
ASSESSMENT
CATEGORIES

(1) technical assessment criteria

(2) environmental assessment criteria, and,

(3) societal assessment criteria.

The amounts of information suggested by these categories is abundant and complex. At the end of this section, you will complete an evaluation of selected delivery systems in order to acquaint you with an assessment process.

(1) Technical Assessment Criteria

This category relates to considerations of the technical efficiency of a delivery system. Some considerations relate to parts or phases of the delivery system, while other considerations relate to the whole system. Some considerations, such as the application of thermodynamics laws and the principles of energetics, may relate to both.

Important considerations in this category are:

(a) Making energy for distribution

We need to know the "state of the art" of the technologies involved. Are these technologies "mature," or highly developed? This has to do with the technical feasibility of the system.

We should also know about the distribution of the costs of parts or whole systems which are under development. We need to know which costs are internalized into production costs, which costs are subsidized, and which are not part of the accounting system, but form externalities.

Another consideration involves the use of existing facilities or the necessity of constructing new ones. Also, does the system involve a centralized or decentralized system of processing, conversion, and/or distribution? If the system technology is based on fossil fuels or other depletable resources, we need to know how adaptable it is for another resource base.

(b) Time constraints on implementation

It is important to know how long the system will take to build, or, if applicable, how long it would take to adapt or retrofit existing facilities. It is important to know also the length of time it would take to resolve patterns of transportation and transmission, especially in terms of transporting the raw and converted materials and transmitting or distributing the final energy form to the consumer,

(c) Maintenance requirements of the system

We should explore the delivery system in terms of its maintenance requirements, not only in terms of direct costs, but also the indirect costs of waste removal and labor, Where in the system are the points of highest and lowest maintenance requirements?

Also, it is valuable to know where in the system there is likelihood of technological accidents and/or human error, and what would be the consequences of these occurrences along the delivery system chain,

(d) Energy efficiency of the delivery system

In terms of the delivery system, it is important to know if there is a net energy yield from energy input to energy output. This requires an examination of the potential energy lost to degradation (such as gasoline losing potency, or batteries losing charge), heat, waste, or physical losses (such as spillage). Also, if any amount of energy is either currently recycled or has the potential for co-generation is an important factor.

In terms of the final energy form or forms resulting from the system, we need to examine its capacity to be used for diverse purposes. Also, we need to know how much energy will result from the system, what it is or will be used for, and how appropriate these end uses are to the energy quality of the original resource. This requires a notion of the net energy yields from resource to end use.

(2) Environmental Assessment Criteria

In this category it is easily possible for assessments to be very specific and dependent on the particular geographic location and settings of each phase of the delivery system. We will define this category as it relates to specific and overall environmental impacts of a delivery system. As in the previous category, some considerations may relate to specific stages of the system, while others may relate to the whole system, and some to both. These considerations include immediate and specific questions regarding exploration and extraction of direct and indirect resources, as well as long-range questions pertaining to overall environmental quality and natural ecosystem stability.

Important considerations in this category are:

(a) Availability of resources required by the delivery system.

In terms of direct resources, we need to know the projected demands to gauge the extent of possible exploration and extraction. Of the proved reserves, it is important to know how much of the resource is accessible, at what rate of extraction, and for how long.

Also crucial here is an examination of projected demands for indirect resources, where in the system they are required, and for how long. These resources include water, materials for building, transportation, and maintenance. Also, where in the production system these costs are accounted for, or subsidized, or passed through as externalities are important considerations.

In terms of transportation, it is useful to know how much physical movement of resources is needed at each stage of delivery, and how much energy is needed to feed these transportation systems.

(b) Observable or hidden effects on air quality

It is important to consider the mass emission rates of air-borne pollutants at particular stages of delivery, who controls and monitors these emissions, and how the pollutant levels rate in comparison with federal, state, and/or local standards for air quality. Perhaps some of the pollutants have been linked with possible ozone depletion.

We should examine what natural systems or people are affected in the emission airshed, what types of discernable odors may occur, when they occur, and how long they might last.

(c) Observable or hidden effects on water quality

For considerations in terms of water quality, we should examine mass emission rates, this time of water-borne pollutants or radioactivity. Also, note the rates of heat discharge into surrounding waters at particular stages of delivery.

Water usage should be considered in terms of the amount of water used from indigenous sources and the amount imported. In this regard, we can ask how much the system affects surface water supplies or the local ground water table.

Water considerations are directly tied to local climate modifications. It is possible that heat discharge, as well as air pollution, can have effects on the local climate for varying lengths of time.

(d) Observable or hidden effects on critical land-related resources

We need to know the projected or existing population changes in the local area, not only to determine energy need, but to determine the long-range effects on the surrounding land use. The impacts of population changes as well as of the delivery system and its stages should be examined in terms of short and long-range effects on the following:

- agricultural, timber-producing, or other forested lands;

- mineral-bearing lands, geothermal sites, or salt-ponds;

- lands with special characteristics, such as wetlands, marshes, coastal zones, estuaries, or fragile lands subject to erosion;

- lands uniquely suited to specific development such as seaports, marinas, airports, or other energy sites;

- biological systems such as flora and fauna, desirable, unusual, noxious, rare, or endangered species;

- the solid waste capacities of the area, such as solid waste volume, resource recovery and recycling, or amounts of toxic materials.

(e) Effects on environmental amenities

Amenities include such aspects as the quality of the visual envionment and the quality of the aural environment. Some structures which are built for a system may impair views or otherwise not "fit" into the surrounding landscape. Visual aspects are also affected by pollution, or other air quality considerations, such as increased dust.

Amenities also include historical or cultural landmarks, monuments, archeological sites, or recreational facilities. It is important to examine the existing or possible effects of a delivery system or its parts on these environmental amenities.

The level of noise may change in the surrounding area. There may be many different types of noises and noise level changes that may last for varying lengths of time. These could include transportation noise, construction noise, and maintenance noises such as trash collection or street sweeping.

Physical waste disposal is also a consideration, affecting not only pollution levels, health, and safety, but visual quality as well. It is important to note where and how much physical waste occurs between distribution and end use, due to accidents or spillage. Also, depending on the final energy product, we can examine how much physical waste occurs at the end use sector, such as spilled goods or throw away containers.

(3) Societal Assessment Criteria

We gave a brief introduction to some of the more general notions included in this category in Section 4, when we discussed energy policy. Any technical innovations or environmental effects will ultimately be felt by the society in which they occur. To accommodate current or projected technical or environmental changes we find it necessary to create new or adapt existing control mechanisms and financial structures. Different social and political demands and risks are associated with different delivery systems and their particular states. We define this category as the relationships between energy systems and politics, law, economics, and social structures.

Important considerations in this category are:

(a) Political consequences of creating, adapting, and/or implementing the system.

Political considerations become crucial when some of the required resources for the system are imported from anywhere outside the area of delivery system jurisdiction. Consider the vulnerability of the system or any of its stages, including resource importation, to sabotage. The risks or consequences of such action must be examined also.

Political considerations include reactions of different segments of the society, and different types of business and industry to policies regarding similar systems. We must ask about public participation in decisions about the system, where and when in the system they are slated to occur, and how information is made available to the public. In this vein, it is useful to know the flexibility of decisions regarding the system, if any are reversible, which ones, and by what processes.

(b) Institutional requirements of implementation

Before implementing any particular delivery system, it is necessary to know if the law currently provides for the system or its parts. Perhaps there are legal or legislative actions being considered or planned to cover any gaps presently existing in the legal system.

The system, or any of its parts, may or may not fall under a current jurisdiction and/or administration. There may be new institutions, agencies, districts, or regions planned to cover the new system, if they are not already in existence. We need to know the current or planned level of inter- and intra-governmental industry, and utility coordination in terms of the delineation and delegation of responsibilities in monitoring and regulation. Will any changes in the administration have effects on public services, such as police or fire protection?

(c) Financial and economic impacts

As we have seen previously, economic aspects of delivery are the most controversial considerations. We need to examine the direct costs of implementation, including the costs of operation, maintenance and replacement, administration, regulation, inspection, and enforcement. Governmental subsidy may cover some of these costs.

Employment is one of the major factors in economic considerations. Examine how many jobs are created or eliminated for any particular stage of the system, as well as secondary jobs for supporting services, or housing construction. Evaluate the earning levels of these jobs, and the resultant distribution of income in the form of wages and salaries.

Often a new or revised system effects property tax bases and rates, sales taxes, special taxes, fees, licenses, or other user changes. The result may be a measurable impact on the local production of goods and services in the industrial, agricultural, and commercial sectors.

There may also be a noticeable impact on local rents for business and industry, as well as for individuals and families.

(d) Effects on lifestyle and quality of life

Projected changes in population may effect the local community in other ways besides land use. The existing housing supply, in terms of housing quality, rehabilitation, and maintenance costs may be effected. There may be removal or conversion of existing units. The costs of land, site preparation, or construction may significantly change.

Examine the effects, both short and long-range, on citizen influence and community control, community character and stability. Consider the system's effects on special population groups, such as the aged, youth, ethnic groups, women, and the handicapped, in terms of employment and services.

Equally important are possible impacts on public health and safety. Hazards sometimes associated with major sites are seismic and flood risks, and risks from pollution (air, water, noise) or toxic substances. Where and how often in the system do hazards such as these occur, and how comprehensive are the prevention measures for these hazards?

Finally, lifestyle considerations involving energy delivery would not be complete without examining the effects on consumer expenditures for goods, services, and energy forms. Will there be any impact on the prices and/or consumption of goods and services? If the energy delivery system alters the amounts or types of energy forms available, look at possible changes of energy demand and consumption and especially any changes in use during peak times or seasons. Also, any public conservation measures (required or voluntary) both current and/or projected, should be examined.

ACTIVITIES

FACILITATING NOTES

- This section may be difficult for some teachers. The concept of technology assessment throws some people simply by the use of the term "technology." Attempt to keep a holistic, systemic viewpoint, and remember to stress the notion of technology assessment as a framework, not a strict methodology.
- Also, maintain the distinction between "technology" assessment and "technical" assessment criteria. The former, as stated before, is a framework. "Technical" criteria are those which have to do with the actual functioning processes of a delivery system and its parts.

ACTIVITY I

1. Answers to Question #1 can be found on p. 261.
2. Suggestions for the scope of the discussion (#2) can also be found on p. 261.

ACTIVITY II

1. There will be an overabundance of pertinent and interesting information, which reflects "real-life" decision-making problems. Make sure to focus on the assessment questions to help weed out extraneous data.
2. Study thoroughly the example answers and matrix on p. 183. This will give you an idea of the level of detail needed for your answers.
3. The group summary (#9) should include your ideas about the overall technical efficiency, environmental impact, and societal impacts for each resource, as well as the comparative aspects of the three delivery systems.
4. At the close of the discussions, the assessments should be evaluated by the group using the evaluation criteria provided on pp. 159-168.

OBJECTIVE: (i) Understand a holistic approach to technology assessment as a tool for influencing energy policy.

READING: Henderson, Hazel. Creating Alternative Futures. New York: Berkeley Publishing Corporation, 1978. Ch. 19, pp. 327-338.

TO DO: Complete the reading and the following exercise:

1. Summarize the two conflicting philosophies which are influencing the current development of technology assessment.

2. Discuss Henderson's ideas about the role of public participation in technology assessment. Refer back to p. 130 in Section 4. How are Henderson's ideas related to the role of citizens in energy policy making?

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OBJECTIVE: (j) Become familiar with holistic criteria for the assessment of selected energy resources.

TO DO: Previously, you were exposed to the examination of selected resources and delivery systems in terms of some general assessment criteria. (Sections 2 & 3.) In this exercise, you will put these considerations together to assess some general issues for selected energy resource delivery systems.

1. As a group, choose three delivery systems from the charts in Section 3. Choose 2 from Conventional Delivery Systems (Fig. 6), and 1 from Nonconventional Delivery Systems (Fig. 7). You may decide to further examine one or more of those resources which you looked at in the activities in Sections 2 and 3. Teachers should break into subgroups to examine each delivery system separately.

2. From these charts and the Energy Flow charts in Ehrlich, Ecoscience, p. 396, or Scientific American, Energy and Power, pp. 86-87, fill in the following sections on the Energy Resource Delivery Assessment Matrix which follows on pp. 175-177 (Fig. 1 & 2):

   - RESOURCE - Check appropriate characterizations in this box;
   - END USE SECTOR or SECTORS - Fill in industrial, residential, etc.;
   - ENERGY USE or USES - Fill in electricity, gasoline, heating, etc.

3. Choose appropriate sections to read about these resource systems from the list of readings following these directions. Each teacher in the subgroup should read at least one thoroughly and skim the others to gain a perspective on controversial issues.

4. The following assessment questions are broken into three categories of criteria: Technical, Environmental, and Societal. Within each of these categories are questions pertaining to stages of energy delivery. There is a separate section of questions following which applies these criteria to the END USE SECTOR of the delivery system. Some questions may not be applicable to every stage, and some questions may not have answers available in the time you have, but you can answer accordingly.

In the Matrix boxes, indicate your answers to the assessment questions in the following manner FOR EACH STAGE of the delivery system. The numbers in the boxes correspond to the question numbers for each category. Make notes on the information that contributes to your answers.

$\boxed{Y}$	YES
$\boxed{N}$	NO
☐	NOT APPLICABLE TO THIS STAGE
$\boxed{0}$	DON'T KNOW

5. As a group, compare and discuss the particulars of your findings in each category.

6. Discuss the end use sectors. How do the original resources compare to each other in terms of particular end use sectors and energy uses?

7. What questions were hardest to answer? Can you think of any particular places, such as government agencies or utility companies where such information could be obtained?

8. Each subgroup complete the Energy Resource Assessment Evaluation for the resource system you examined.

9. Create a written group summary on the major aspects of your assessments, focusing on those delivery systems which exhibit aspects or impacts that are particularly similar or dissimilar. This can be brief.

10. Following the Assessment questions are sample portions of an Energy Resource Delivery Assessment for coal. The numbered boxes are the same as those in this exercise. The reasons for these answers are briefly outlined following the sample matrix.

READING:

Berger, John J., Nuclear Power: The Unviable Option. Palo Alto, CA; Ramparts Press, 1976. (Use this for nuclear energy analysis.)

Clark, Wilson, Energy for Survival. Garden City, New York: Anchor Press/Doubleday, 1974. Chapters 5, 6, and 7.

Ehrlich, Paul, Ehrlich, Anne, and Holdren, John. Ecoscience: Population, Resources, Environment. San Francisco: W.H. Freeman and Co., 1977. Chapter 8: "Energy," pp. 400-490: Resources and Technology. Chapter 10: "Air Pollutants," pp. 542-556. "Water Pollution," pp. 556-561; "Radiation," pp. 579-586; "Noise Pollution," pp. 596-597.

Miller, G. Tyler, Living in the Environment. Belmont, CA: Wadsworth Publishing Co., Inc., 1975. Enrichment Study #10: "Nuclear Energy Dilemma," pp. E69-E85. Enrichment study #20: "Some Energy Alternatives: Fusion, Solar, Geothermal, Wind and Conservation," pp. E148-E161. Tables 13-2 & 13-3, pp. 231-232.

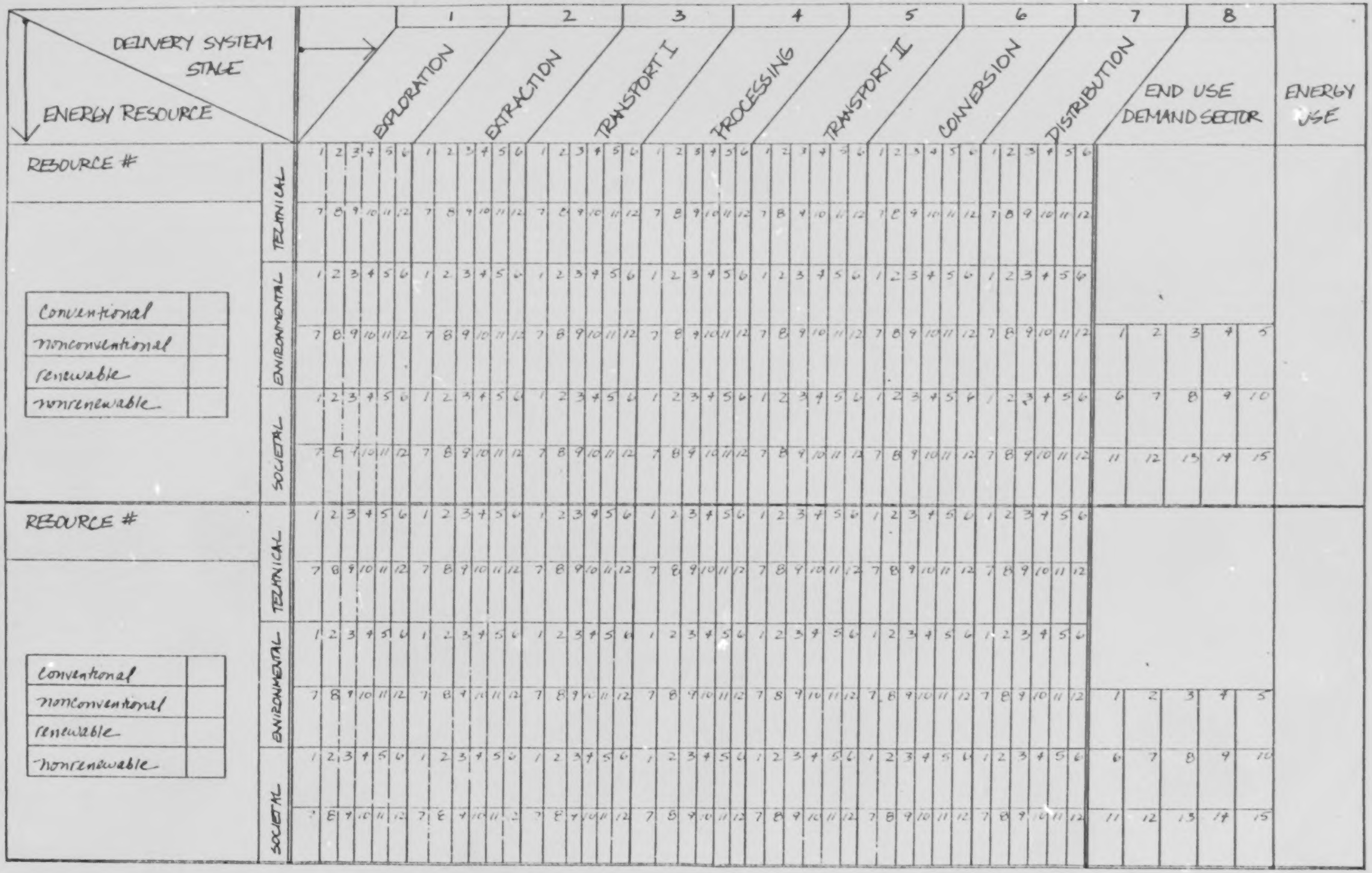
Steinhart, Carol, and Steinhart, John, Energy. North Scituate, Mass.: Duxbury Press, 1974. Part II, appropriate sections on "Energy Resources."

Tuve, George L., Energy, Environment, Populations, and Food. New York: Wiley-Interscience Publication/John Wiley and Sons, 1976. Chapter Three: "Energy Technology and Energy Supplies."

DELIVERY SYSTEM STAGE ENERGY RESOURCE		1 EXPLORATION	2 EXTRACTION	3 TRANSPORT I	4 PROCESSING	5 TRANSPORT II	6 CONVERSION	7 DISTRIBUTION	8 END USE DEMAND SECTOR	ENERGY USE
RESOURCE #	TECHNICAL	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6		
		7 8 9 10 11 12	7 8 9 10 11 12	7 8 9 10 11 12	7 8 9 10 11 12	7 8 9 10 11 12	7 8 9 10 11 12	7 8 9 10 11 12		
Conventional nonconventional renewable nonrenewable	ENVIRONMENTAL	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6		
		7 8 9 10 11 12	7 8 9 10 11 12	7 8 9 10 11 12	7 8 9 10 11 12	7 8 9 10 11 12	7 8 9 10 11 12	7 8 9 10 11 12	1 2 3 4 5	
	SOCIETAL	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	6 7 8 9 10	
		7 8 9 10 11 12	7 8 9 10 11 12	7 8 9 10 11 12	7 8 9 10 11 12	7 8 9 10 11 12	7 8 9 10 11 12	7 8 9 10 11 12	11 12 13 14 15	
RESOURCE #	TECHNICAL	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6		
		7 8 9 10 11 12	7 8 9 10 11 12	7 8 9 10 11 12	7 8 9 10 11 12	7 8 9 10 11 12	7 8 9 10 11 12	7 8 9 10 11 12		
conventional nonconventional renewable nonrenewable	ENVIRONMENTAL	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6		
		7 8 9 10 11 12	7 8 9 10 11 12	7 8 9 10 11 12	7 8 9 10 11 12	7 8 9 10 11 12	7 8 9 10 11 12	7 8 9 10 11 12	1 2 3 4 5	
	SOCIETAL	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	6 7 8 9 10	
		7 8 9 10 11 12	7 8 9 10 11 12	7 8 9 10 11 12	7 8 9 10 11 12	7 8 9 10 11 12	7 8 9 10 11 12	7 8 9 10 11 12	11 12 13 14 15	

ENERGY RESOURCE DELIVERY ASSESSMENT

FIGURE 1



ENERGY RESOURCE DELIVERY ASSESSMENT
FIGURE 2

Technical Assessment Criteria

1. Are the technologies for this stage at a "mature" phase of development.
2. Are the costs at this stage internalized into production costs?
3. Does this stage utilize existing types of facilities? (Structures, machinery, pipelines, equipment, etc.)
4. Are the facilities of this stage adaptable to another energy resource base?
5. Can the facilities for this stage be retrofitted or created in less than two years?
6. Can the physical transportation aspects of this stage be organized and in process in less than two years?
7. Can the facilities for the transmission of electricity at this stage be built and functional in less than two years?
8. Does this completed and functional stage involve specialized maintenance of equipment? (not including standard transportation maintenance)
9. Does this stage rely on specialized training or skills for the operation of equipment or facilities? (not including driving heavy machinery)
10. Is there a likelihood that human error or technological accident at this stage could cause damage to the environment or risk to humans?
11. Does this stage involve over 10% energy degradation to heat or waste?
12. Does this stage involve any current or potential recycling or co-generation?

Environmental Assessment Criteria

1. Do the operations in this stage involve any demand for water?

2. Does this stage involve any demand for physical transportation of the resource or its products from one site to another?

3. Are there air-borne pollutants associated with this state that arise from the resource or its products?

4. Are there discernable odors associated with this stage that arise from the resource or its products?

5. Do odors seem to last a long time in the immediate area? (For example, over 5 hours?)

6. Are there water-borne pollutants associated with this stage? (Including heat or radiation?)

7. Is there noise pollution associated with this stage of delivery?

8. Do noise disturbances seem to last a long time? (For example, over 1/2 hour continuously?)

9. Are there immediate impacts on any critical land-related resources?

10. Are there any possible or proven long-range impacts on any land-related resources?

11. Is there a likelihood of disturbances or destruction of historic or cultural landmarks associated with this stage, for example, visual or aesthetic disturbance, alteration or removal?

12. Is there a noticeable quantity of physical waste associated with this stage of delivery?

Societal Assessment Criteria

1. Does this stage involve any vulnerability and risk from sabotage which could endanger the public health or safety?
2. Is information of a non-technical nature about this stage easily available to the public from coal industries and for government?
3. Is there a probability of effective local public participation in decisions about this stage?
4. Are political decisions regarding this stage of delivery flexible and/or easily reversible?
5. Does the law currently provide for government regulation and/or government monitoring of this stage of delivery? (Or is there legal or legislative action being planned or pending?)
6. If this stage is operational, is it mandated to be under the control of elected officials? If it is not yet operational, do you think it should be controlled by elected officials?
7. Does this stage involve government subsidy of direct costs of implementation? (Such as costs for operation and maintenance, replacement, administration, regulation, inspection, and enforcement.)
8. Does this stage always involve the creation of diverse employment?
9. Does this stage always involve the elimination of jobs?
10. Does this stage always involve the removal or conversion of existing housing units?
11. Would this stage be involved in risks from seismic or flood hazards?
12. Does this stage create or involve any public health hazards? (such as pollution, radiation, or toxic substances)

End Use Criteria

Technical

1. Are over 2/3 of the end uses appropriate to the energy quality of the original resource?

2. Is there an existent or probable net energy yield of over 10/1 $\left[\frac{\text{energy produced}}{\text{energy costs}}\right]$ to the end use sector?

Environmental

3. Is there any usual or potential physical waste occurring between distribution and end use? (accidents, spillage, etc.)

4. Is there any usual or potential physical waste at the end sector? (spillage, throw-away containers, etc.)

5. Could the system affect surface water supplies or the local ground-water table?

Societal

6. Do any energy industries or utilities have adverse reactions to this or similar delivery systems?

7. Does this system require increased use of public services at the site (such as police or fire protection)?

8. Does this system have the effect of increasing property tax bases or rates in the local area or areas throughout the system?

9. Does this system have the effect of introducing or increasing sales taxes, special taxes, fees, licenses, or user charges to the consumer of the energy product?

10. Does this system have adverse effects on the production of and access to goods and services involving the energy product?

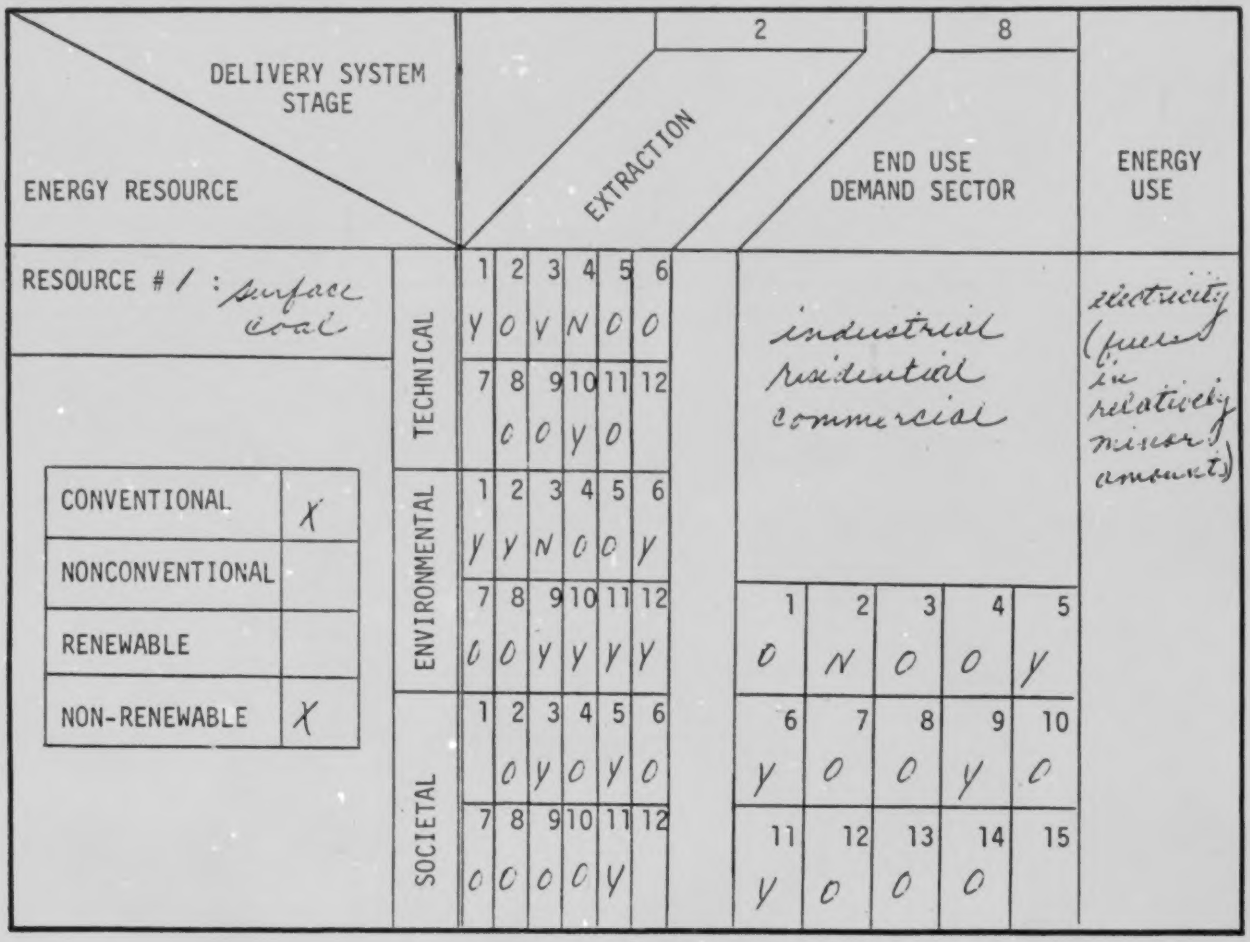
11. Does this system have the effect of increasing energy demand and consumption of the energy products?

12. Does this system have the effect of increasing the cost of land and/or housing and/or rents in the area or areas of production or conversion sites?

13. Does this system have adverse effects on the community character? (For example, high-rise buildings, extensive suburb development, changes in traditional events?)

14. Does this system have adverse effects on any special population groups such as ethnic groups, creating relocation or price inequities?

15. Do you have adverse reactions regarding this or similar delivery systems?


DELIVERY SYSTEM STAGE
ENERGY RESOURCE
2
8
EXTRACTION
END USE DEMAND SECTOR
ENERGY USE

RESOURCE # 1 : surface coal

CONVENTIONAL	X
NONCONVENTIONAL	
RENEWABLE	
NON-RENEWABLE	X

EXTRACTION

	1	2	3	4	5	6	7	8	9	10	11	12
TECHNICAL	Y	O	Y	N	O	O		O	O	Y	O	
ENVIRONMENTAL	Y	Y	N	O	O	Y	O	O	Y	Y	Y	Y
SOCIETAL		O	Y	O	Y	O	O	O	O	O	Y	

END USE DEMAND SECTOR: industrial
residential
commercial

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
O	N	O	O	Y	Y	O	O	Y	O	Y	O	O	O	

ENERGY USE: electricity (fueled in relatively minor amounts)

EXTRACTION: STAGE #2

Technical Criteria

1. Both surface and underground techniques are highly developed.
2. Costs of extraction contribute differently to costs of coal, depending on how much coal is extracted, and the costs of reclamation.
3. Since techniques are highly developed, most current types of equipment can be used.
4. Coal technologies are highly specialized mining techniques.
5. Information not readily available.

6. Transportation already in place for current facilities, unknown for new facilities.

7. Not applicable.

8. Information not readily available.

9. Information not readily available.

10. Hazards to humans are less likely than environmental disruption, which includes erosion, down-slope motion of earth, siltation of local streams, acid runoff and acid soil.

11. Information not readily available.

12. Not applicable.

Environmental Criteria

1. Surface or strip mining calls for large amounts of water.

2. Extracted coal must be shipped to processing facilities.

3. No pollution from coal itself in surface mining, but coal dust is a major hazard in underground mining.

4. Unknown.

5. Unknown.

6. In rocks where coal is rich in pyrite, this mineral is oxidized to sulfate and sulfuric acid.

7. Unknown.

8. Unknown.

9. Immense amounts of displaced overburden changing land contours, siltation of local streams; soil acidification kills stream life and vegetation.

10. Changed land contours and functions, landslides, possible revegetation and changed animal life.

11. Visual and aesthetic destruction of scenery is readily apparent.

12. Large amounts of physical waste in terms of overburden removed from coal seams and deposited elsewhere.

Societal Criteria

1. Not applicable.
2. Unknown.
3. Environmental concerns can be made known at hearings which must be held according to the Environmental Protection Agency.
4. Unknown.
5. The Federal government monitors extraction and transportation of coal; also commitments to protect National Parks and Wilderness areas through strip-mine legislation; Clean Air Act to protect air quality.
6. Unknown.
7. Unknown.
8. Unknown.
9. Unknown.
10. Unknown.
11. Possible landslides are a high risk in flood situations for surface-mined area, also increased acid contamination in surface water and soils.
12. Sulfuric acid is highly toxic to all plant and animal life, including humans; this substance is a likely by-product of high-sulfur coal mining and can enter the water supply.

End Use Criteria

1. Unknown.
2. About two thirds of the energy released by burning fossil fuels to generate electricity is lost at the power plant site as unutilized, waste heat.
3. Unknown, but would apply to fuels only.
4. Same as #3.
5. Sulfuric acid possiblities - See Environmental Criteria #6, Societal Criteria #1.
6. Industries have most reaction to air and water pollution control measures for coal-fired power plants.

7. Unknown.

8. Unknown.

9. Substituting coal for much of oil and natural gas will increase costs to consumer because of having to cover air pollution controls, land reclamation, improved mining safety practices, increased shipping costs.

10. Unknown, but possible inequities of utility charges.

11. As coal-fired electricity and coal-based fuels become more readily available, demand will increase.

12. Unknown.

13. Unknown.

14. Unknown, but possible effects on Native American groups include relocation, pollution of formerly clean air, and price inequities.

15. It's up to you!

ENERGY RESOURCE DELIVERY AND USE
EVALUATION OF YOUR ENERGY RESOURCE DELIVERY ASSESSMENT

This evaluation assesses the completeness of your Assessment Matrix. Do the following for each resource you have assessed:

- For each criteria category (technical, environmental, societal, and end use), total up the number of questions which you could answer, and fill in the boxes below accordingly.
COUNT ONLY THOSE QUESTIONS WHICH YOU ANSWER BY A "YES" (Y), "NO" (N), OR "NOT APPLICABLE" ( ). DO NOT COUNT THE "DON'T KNOW" (0).
- For those resource delivery stages which are totally non-existent, give yourself the total point score for that stage.

Criteria Category	Possible for ea. category	Resource #1	Resource #2	Resource #3
TECHNICAL	84			
ENVIRONMENTAL	84			
SOCIETAL	84			
END USE	15			
TOTAL	267			
INFORMATION BASE SCORE				

Evaluation (cont'd)

- The completeness of your information base is indicated by comparing your total score with the rating below:

Total Score	Rating	Information Base Score
235 or above	very complete	3
190-235	adequate	2
150-190	minimal coverage	1
below 150	inadequate	0

- Fill in your Information Base Score in the boxes provided above.
- Compare your scores for the different resource systems. According to this rating system, which did you investigate most thoroughly?

The written text, readings and activities of the INQUIRY were organized and presented for the purpose of providing you with a knowledge base about energy resource delivery. It would be useful now to review as a group the goals stated at the beginning of the INQUIRY before proceeding to the INTEGRATION.

As a group, have you covered the material comprehensively enough to understand the following:

1. Specific attitudes and worldviews which have implications for energy use?
2. The types and nature of energy resources in terms of considerations for delivery?
3. The concepts and processes of energy resource delivery and use?
4. The basis for evaluating energy policy decisions?
5. An integrated approach to the assessment of energy resource delivery and use?

INTEGRATION involves the teacher in ayalyzing and evaluating an energy policy plan.

INTEGRATION

INTEGRATION

Throughout this module, you have been exposed to important concepts and principles associated with the environmental problem area of Energy Resource Delivery and Use. You have also seen the range of concerns associated with energy policy. In order to synthesize this information base into a whole that will help you become a more effective, environmentally aware citizen, this INTEGRATION focuses on the evaluation of an energy policy plan. This evaluation utilizes the types of information you have been working with in this module.

The overall goal of the INTEGRATION is:

> (D) To develop teachers' critical facilities for the holistic evaluation of an energy policy.

This section presents a synthesis activity for integrating the concepts and principles explored in the INQUIRY into a group statement about the National Energy Plan. An important thing to remember is that energy policies are constantly changing, and that the National Energy Plan is currently undergoing revision and review. Also, policies such as the National Energy Plan and analyses such as the OTA Analysis have undergone much background research that is not readily apparent. Make sure to keep in mind the changing nature of these policy and analysis statements.

RESOURCES THAT WILL BE NEEDED:

Order at least half as many National Energy Plans as there are teachers, so teachers can share. The group should have available at least one OTA Analysis, in order to make copies of relevant sections. If you do not wish to copy from this document, order at least one fourth as many OTA Analyses as there are teachers in the group, so Group 1 can share.

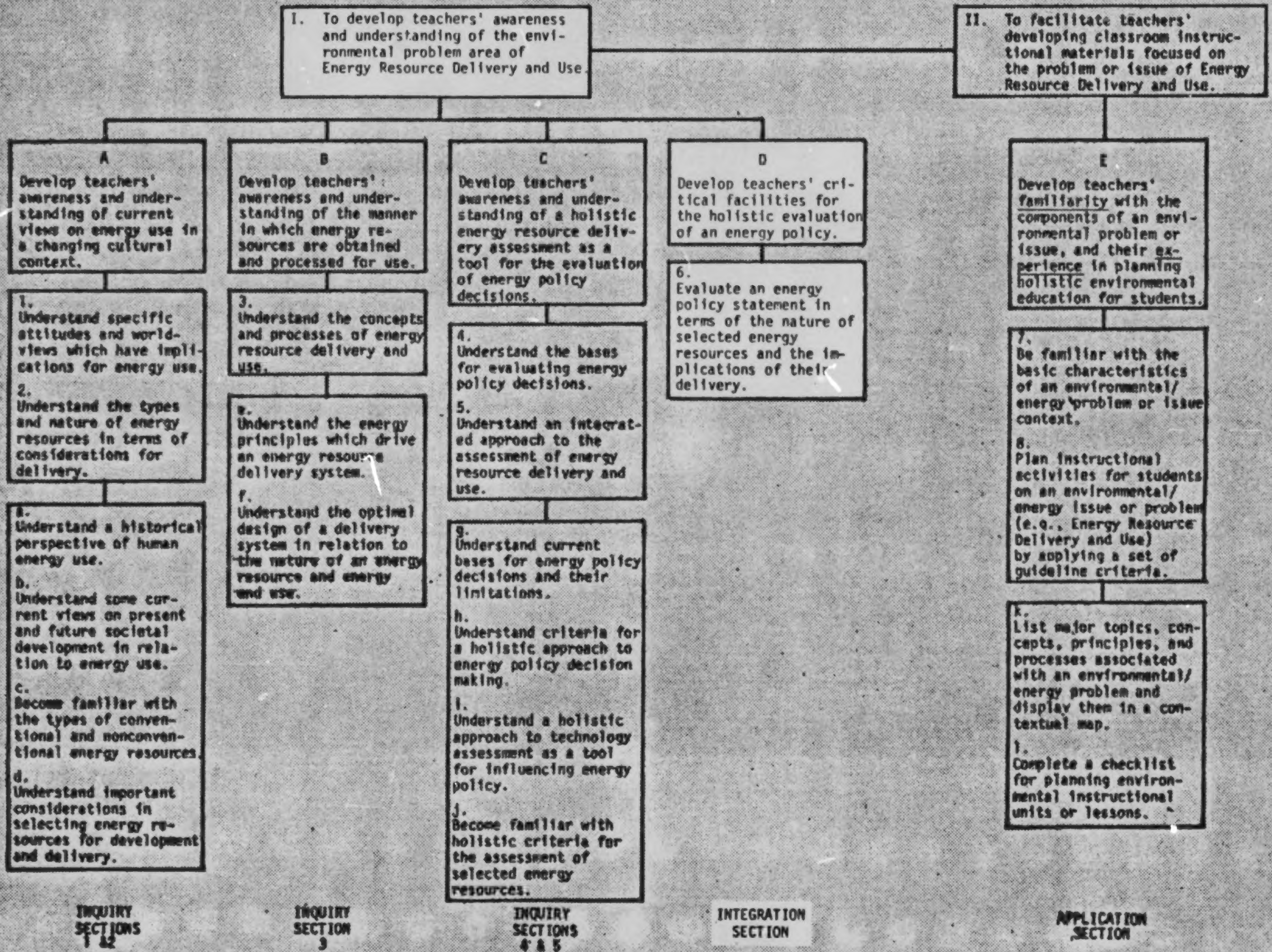
THINGS TO WHICH OUT FOR:

Teachers may get too involved with the political aspects of the National Energy Plan. Remember that we have developed a comprehensive framework for these evaluations in the INQUIRY. Keep your holistic perspective throughout this Activity.

The Module's Goals and Objectives Chart follows. Only those goals relevant to information presented in the INTEGRATION are highlighted.

2 7

MODULE GOALS AND OBJECTIVES



I. To develop teachers' awareness and understanding of the environmental problem area of Energy Resource Delivery and Use.

II. To facilitate teachers' developing classroom instructional materials focused on the problem or issue of Energy Resource Delivery and Use.

A

Develop teachers' awareness and understanding of current views on energy use in a changing cultural context.

1. Understand specific attitudes and world-views which have implications for energy use.

2. Understand the types and nature of energy resources in terms of considerations for delivery.

a. Understand a historical perspective of human energy use.

b. Understand some current views on present and future societal development in relation to energy use.

c. Become familiar with the types of conventional and nonconventional energy resources.

d. Understand important considerations in selecting energy resources for development and delivery.

INQUIRY SECTIONS 1 &2

B

Develop teachers' awareness and understanding of the manner in which energy resources are obtained and processed for use.

3. Understand the concepts and processes of energy resource delivery and use.

e. Understand the energy principles which drive an energy resource delivery system.

f. Understand the optimal design of a delivery system in relation to the nature of an energy resource and energy end use.

INQUIRY SECTION 3

C

Develop teachers' awareness and understanding of a holistic energy resource delivery assessment as a tool for the evaluation of energy policy decisions.

4. Understand the bases for evaluating energy policy decisions.

5. Understand an integrated approach to the assessment of energy resource delivery and use.

g. Understand current bases for energy policy decisions and their limitations.

h. Understand criteria for a holistic approach to energy policy decision making.

i. Understand a holistic approach to technology assessment as a tool for influencing energy policy.

j. Become familiar with holistic criteria for the assessment of selected energy resources.

INQUIRY SECTIONS 4 & 5

D

Develop teachers' critical facilities for the holistic evaluation of an energy policy.

6. Evaluate an energy policy statement in terms of the nature of selected energy resources and the implications of their delivery.

INTEGRATION SECTION

E

Develop teachers' familiarity with the components of an environmental problem or issue, and their experience in planning holistic environmental education for students.

7. Be familiar with the basic characteristics of an environmental/energy problem or issue context.

8. Plan instructional activities for students on an environmental/energy issue or problem (e.g., Energy Resource Delivery and Use) by applying a set of guideline criteria.

k. List major topics, concepts, principles, and processes associated with an environmental/energy problem and display them in a contextual map.

l. Complete a checklist for planning environmental instructional units or lessons.

APPLICATION SECTION

GENERAL FACILITATING NOTES (cont'd.)

1. Skim the entire Activity before proceeding to gain a sense of the major considerations.

2. For Part 1, you may wish to make copies of relevant readings, if there are not enough copies of the entire OTA document.

3. Also, for Part 1, make sure to review the indicated pages in Section 4.

4. For Part 1, the group can assign parts (1) - (4) to different people.

5. For Part 2, the group should refer as much as necessary to the module text and INQUIRY resources to refresh your memories about these concepts.

6. For Part 2, the group can assign different resources to different people.

7. For Part 3, again refer as often as necessary to the indicated module text. The Summary Statement can be one or two paragraphs on each major consideration (#1, 2, 3). However, make sure all these aspects are addressed in your evaluations and conclusions.

To ensure that teachers share the responsibility for a holistic evaluation, divide into two groups. These groups evaluate different aspects of the energy policy plan. Then, the two groups come together to create a summary statement or final report of your findings. When this summary is complete, your group will have addressed the following objective:

(6) To evaluate an energy policy statement in terms of the nature of selected energy resources and the implications of their delivery.

Please read through the general directions which follow before beginning the activities.

Your group should have available enough copies of the following documents:

> Executive Office of the President, Energy Policy and Planning, The National Energy Plan. Washington, D.C.: U. S. Government Printing Office, April 29, 1977.
>
> Office of Technology Assessment (OTA), Analysis of the Proposed National Energy Plan. Washington, D.C.: U.S. Government Printing Office, August, 1977.

GENERAL DIRECTIONS

a. ALL TEACHERS READ the following:

- Review Section 4 in the module
- Read the entire National Energy Plan.
- Read pp. 1-6 and pp. 9-18 in the OTA Analysis.

Break into two subgroups, and complete Parts 1 and 2:

b. Part 1, Group 1: Complete the Energy Plan Evaluation Outline, by reviewing the National Energy Plan, reading the appropriate Issues in the OTA Analysis, and working with the knowledge you have acquired throughout the module. Appropriate readings in the OTA Analysis are indicated in the Evaluation Outline, p. 199.

c. Part 2, Group 2: Complete an Energy Resource Delivery Rating Chart to help you assess the National Energy Plan in terms of selected resources and the implications of their delivery. Directions for this exercise are on p. 204.

Come back together as a large group, and complete Part 3:

d. Part 3, Entire group: Create a group Summary Statement reflecting the group's conclusions about the strengths, weaknesses, and/or deficiencies in the National Energy Plan. Directions for this final activity are on p. 206.

PART ONE: ENERGY PLAN EVALUATION OUTLINE

This Outline provides Group 1 with a framework for evaluating the National Energy Plan utilizing the components of a holistic policy approach (discussed on p. 123 of this module). *The information you gather here will be used to contribute to the group Summary Statement at the end of this exercise.* Each Outline section includes the following:

- a question which proposes the major focus of the analysis and indicates the pages in Section 4 relevant to your discussions;
- a listing of those Issues in the OTA Analysis which are applicable reading and,
- an empty page for you to make notes about this policy issue, including any points for further discussion or clarification.

Remember, as you are reading these documents, there may be many points for which background information seems to be necessary but is not readily apparent. These points should all be included in your notes. Also include reasons why you agree or disagree with the OTA discussions on energy policy issues.

(1) The Role of Economics

- Major Focus:

  How comprehensively does the National Energy Plan seem to address the energy economy, including the efficiency of fuels and the ways they are used? (refer to pp. in module)

- Readings in OTA *Analysis of the National Energy Plan*:

  pp. 39-41, 84-87, 88-91, 105, 109-110, 111-112, 115-118, 134-135, 136-139, 150-152, 192-193.

- Clarification:

  List points or questions you may have which do not seem to be comprehensively addressed in either the *National Energy Plan* or the OTA *Analysis*.

(2) The Notion of Appropriate Technology

- Major Focus:

  In what manner does the National Energy Plan address the concerns of the appropriate technology concept? (refer to pp. 125-126 in the module).

- Reading in OTA Analysis:

  pp. 64-65, 66-68, 69-71, 72-73, 95-98, 100-102, 103-104, 106-107, 108, 127-130, 168-170, 196, 197-200.

- Clarification:

  List points or questions you may have which do not seem to be comprehensively addressed in either the National Energy Plan or the OTA Analysis.

(3) The Role of Government and Utilities

- Major Focus:

  What are the major aspects of government and utility responsibilities in the National Energy Plan?

- Reading in the OTA *Analysis*:

  pp. 119-120, 121-122, 123-125, 126-, 127-130, 142-143, 174-176, 177, 178, 179, 185-187, 188-189.

- Clarification:

  List points or questions you may have which do not seem to be comprehensively addressed in either the *National Energy Plan* or the OTA *Analysis*.

(4) The Role of Citizens

- Major Focus:

  Either stated or implied, how does the National Energy Plan allow for the effective participation of citizens in energy policy decisions?

- Reading in OTA Analysis:

  pp. 57-58, 88-91, 108, 153-156, 163-164, 171, 172-173, 180-181, 201-202.

- Clarification:

  List points or questions you may have which do not seem to be comprehensively addressed in either the National Energy Plan or the OTA Analysis.

PART TWO: ENERGY RESOURCE AND DELIVERY RATING

To create a group statement about the National Energy Plan, you need to synthesize the information from the Activities of both Group 1 and Group 2. Following this page is a tool for Group 2 to use as the basis for your discussions. This is in the form of an Energy Resource Delivery Rating Chart. This Chart helps you assess the comprehensiveness of the National Energy Plan in terms of selected energy resources and the implications of their delivery.

After your group completes the Rating Chart, you will then contribute to a written summary about your group's conclusions with regard to the National Energy Plan. Complete directions for this Statement follow in Part 3, p. 206.

ENERGY RESOURCE DELIVERY RATING CHART: DIRECTIONS

1. Do this exercise as a group.

2. In the final column, fill in another resource your group feels is important to the National Energy Plan.

3. To evaluate the comprehensiveness of the National Energy Plan in terms of selected energy resources, answer the questions on the next page about each resource delivery system by using the rating scale below:

0	1	2	3
NOT AT ALL	SOMEWHAT	ADEQUATELY	VERY WELL

4. Total each column for a general comparison

5. Make any other comments for comparison in the last row.

By direct statement or implication, how well do you think the National Energy Plan covers the following for each type of resource delivery system listed here?	PETROLEUM	NATURAL GAS	COAL	NUCLEAR ENERGY	HYDRO POWER	SOLAR ENERGY	GROUP CHOICE
• the renewable/nonrenewable nature of the energy resource							
• the types of end uses supplied by the resource							
• the technical efficiency of the delivery system							
• possible adaptations or alternatives to the delivery system to increase energy efficiency							
• the environmental impacts of the system: air, water, land							
• the governmental or administrative considerations involved in implementing or continuing this type of delivery system							
• the legal or legislative considerations involved in implementing or continuing this type of delivery system							
• the economic costs to the consumer involved in implementing or continuing this type of delivery system							
• the employment considerations of this type of system							
• the health and safety factors involved in implementing or continuing this type of system							
TOTAL							

OTHER COMMENTS

ENERGY RESOURCE DELIVERY RATING CHART

PART THREE: GROUP SUMMARY STATEMENT

Your final group activity is to create a written Summary Statement about your group's conclusions with regard to the National Energy Plan. This can be brief, and should include your Rating Scale for reference. Your group Summary Statement should address the following considerations.

1. An evaluation of the National Energy Plan in terms of the components of holistic energy policy making (refer to p. 123 of the module and your notes from Part 1 of this INTEGRATION).
   - the role of economics:
   - the notion of appropriate technology;
   - the role of government and the utilities; and,
   - the role of citizens.
2. An evaluation of the National Energy Plan in terms of your understanding of the nature of particular energy resources and the implications of their delivery (refer to your Energy Resource Delivery Rating Chart from Part 2 of this INTEGRATION).
3. From the information and conclusions obtained from Groups 1 and 2, synthesize a summary evaluation statement about the National Energy Plan in terms of each of the following energy policy goals (refer to p. 114 in the module):
   - efficient economic and energetic use of nonconventional energy resources;
   - low cost and abundant supply to consumers;
   - protection from supply interruption;
   - conservation of the environment;
   - minimizing the depletion of domestic resources; and,
   - limiting the impact on federal, state, and local budgets.

Before proceeding with the APPLICATION, it may be useful to review, as a group, the goals and objectives for the INQUIRY and INTEGRATION.

As a group have you covered the material comprehensively enough to:

1. Develop the critical facilities necessary for the holistic evaluation of an energy policy?
2. Evaluate an energy policy statement in terms of the nature of the selected energy resources and the implications of their delivery?

APPLICATION presents a set of guidelines for planning and implementing instructional programs on the nature of Energy Resource Delivery and Use.

APPLICATION

APPLICATION

This APPLICATION provides you with an opportunity to plan an environmental instructional unit(s) or lesson(s) for classroom use which are holistic, transdisciplinary, and issue-focused. The APPLICATION, then, constitutes an exercise in designing a learning experience or set of experiences which raises students' levels of awareness and understanding of Energy Resource Delivery and Use.

The APPLICATION in two sections presents:

> The Environmental Problem Context--this section describes the general characteristics of an environmental problem or issue as the primary focus for an instructional unit or lesson.
>
> Checklist for Planning Environmental/Energy-Focused Instructional Units or Lessons--
>
> This section presents guideline questions for planning and developing environmental problem-focused instructional materials and activities.

After completing the APPLICATION section, you should:

(E) Have a familiarity with the components of an environmental problem or issue context, and experience in planning holistic environmental education instruction and learning for students.

1. You should begin by reading through the entire APPLICATION (The Appendices are optional).

2. If the group feels the need to agree upon a definition of environmental education (EE) before beginning the instructional planning process, you can start by reviewing the definition provided in the module's PREFACE, page 11 . You should be aware that EE can also be thought of as:

    - the study of everything--nature, humankind, all disciplines and fields of knowledge;
    - the study of human beings' interaction with nature (the biosphere);
    - the study of the relationships between nature and human systems; and
    - the study of reciprocal or optimal ways to manage the relationships between natural and human systems.

3. "Warm up" to the planning process by discussing and selecting some aspects of Energy Resource Delivery and Use which interest you and might interest your students. Consider how the environmental problem issue of energy use relates to your own professional subject area. For example, you might start the planning task by identifying energy delivery topics, concepts, and principles which are compatible with your subject area; the possibilities might include: net energy and energy quality, cycles, world views, social and economic constraints, etc.

4. Keep in mind that, when planning the student learning activities, the ultimate goal of the instructional plan is to develop in students a level of awareness and understanding regarding energy delivery and use that approaches the level you and the other teachers achieved after completing the INQUIRY and INTEGRATION materials.

5. You can begin planning an environmental instructional unit or lesson for your students by using:

    - the contextual map you develop in the Activity; and
    - the checklist to ensure the adequacy of your instructional plan.

6. Remember, you can utilize the planning checklist in any one of the three ways recommended on p. 230.

7. You can create a unit plan in one of the following ways (whichever is the most comfortable for you):

   - Work individually at first; then share and refine your ideas and plans in a group discussion.
   - Work with another person at first, then share and refine your ideas and plans in a whole group discussion.
   - Work in a whole group to develop a common plan which each teacher can live with and carry out in his/her classroom.

   You should find these group discussions most helpful in: (a) sharing ideas and suggestions, and (b) developing a common set of "notes" which can be used subsequently to select specific instructional materials from or to develop more detailed, classroom-ready environmental, energy-focused activities for your students.

8. You should set a specific time limit (1 week, 3 weeks, 6 weeks, etc.) for your unit--even though this time limit may be changed later--since doing so will help provide you with some concrete limits within which to plan student learning experiences.

9. Remember to specify a particular setting (local, state, regional, etc.) and problem focus in which you might want your students to examine energy delivery topics, concepts, and principles.

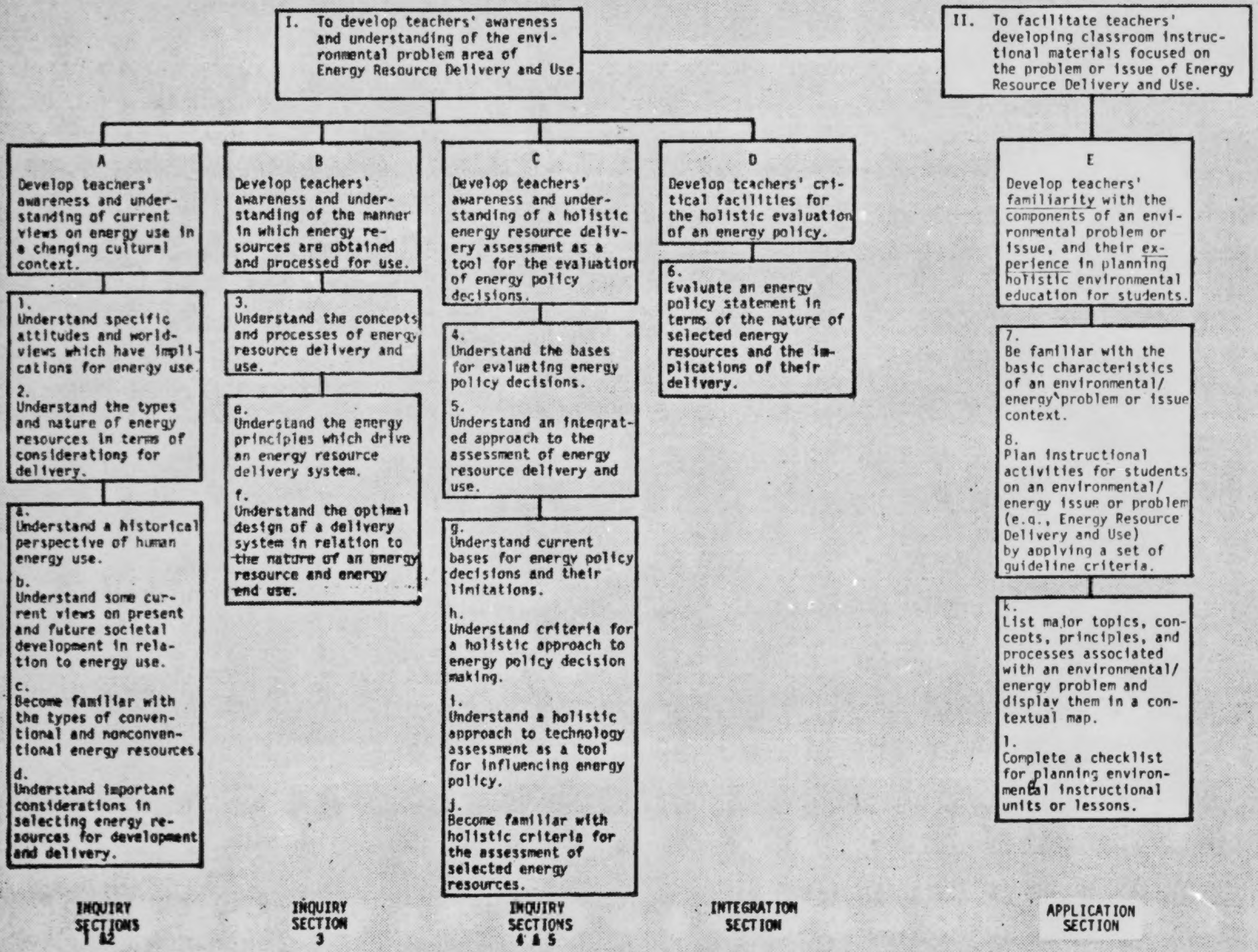
10. If you and the other teachers have developed individual instructional plans, go over them in a group discussion and compare them with the guidelines in the checklist. In particular, you should make certain that your plans are specific regarding:

    - the problem context--including topics, concepts, processes that will be covered or utilized (Note: these should address at least some of the topic-and process-oriented contents identified on p. 221.
    - instructional aims or learning objectives;
    - learning resources (readings, people, exercises/activities);
    - evaluation criteria and procedures;
    - time schedule or sequence for learning activities.

11. Do not avoid this planning activity on the basis of your intention or desire to later explore with your students some energy use problem/topic areas compatible with their interests. You will find that your initial planning efforts, though tentative, will pay off by better helping you to propare for implementing environmental education in your classroom.

The Module's Goals and Objectives Chart follows. Only those goals relevant to information presented in the APPLICATION are highlighted.

MODULE GOALS AND OBJECTIVES



I. To develop teachers' awareness and understanding of the environmental problem area of Energy Resource Delivery and Use.

II. To facilitate teachers' developing classroom instructional materials focused on the problem or issue of Energy Resource Delivery and Use.

A

Develop teachers' awareness and understanding of current views on energy use in a changing cultural context.

1. Understand specific attitudes and worldviews which have implications for energy use.

2. Understand the types and nature of energy resources in terms of considerations for delivery.

a. Understand a historical perspective of human energy use.

b. Understand some current views on present and future societal development in relation to energy use.

c. Become familiar with the types of conventional and nonconventional energy resources.

d. Understand important considerations in selecting energy resources for development and delivery.

INQUIRY SECTIONS 1 &2

B

Develop teachers' awareness and understanding of the manner in which energy resources are obtained and processed for use.

3. Understand the concepts and processes of energy resource delivery and use.

e. Understand the energy principles which drive an energy resource delivery system.

f. Understand the optimal design of a delivery system in relation to the nature of an energy resource and energy end use.

INQUIRY SECTION 3

C

Develop teachers' awareness and understanding of a holistic energy resource delivery assessment as a tool for the evaluation of energy policy decisions.

4. Understand the bases for evaluating energy policy decisions.

5. Understand an integrated approach to the assessment of energy resource delivery and use.

g. Understand current bases for energy policy decisions and their limitations.

h. Understand criteria for a holistic approach to energy policy decision making.

i. Understand a holistic approach to technology assessment as a tool for influencing energy policy.

j. Become familiar with holistic criteria for the assessment of selected energy resources.

INQUIRY SECTIONS 4 & 5

D

Develop teachers' critical facilities for the holistic evaluation of an energy policy.

6. Evaluate an energy policy statement in terms of the nature of selected energy resources and the implications of their delivery.

INTEGRATION SECTION

E

Develop teachers' familiarity with the components of an environmental problem or issue, and their experience in planning holistic environmental education for students.

7. Be familiar with the basic characteristics of an environmental/energy problem or issue context.

8. Plan instructional activities for students on an environmental/energy issue or problem (e.g., Energy Resource Delivery and Use) by applying a set of guideline criteria.

k. List major topics, concepts, principles, and processes associated with an environmental/energy problem and display them in a contextual map.

l. Complete a checklist for planning environmental instructional units or lessons.

APPLICATION SECTION

SECTION 1

THE ENVIRONMENTAL PROBLEM CONTEXT

After completing this section, you should:

(7) Be familiar with the basic characteristics of an environmental issue context.

Before beginning the instructional planning process, it is useful to examine those aspects of an environmental, energy-focused problem context considered by curriculum designers to be suitable for increasing students' broad understanding of energy and environmental problems and issues.

An environmental problem context which is suitable or appropriate for students must involve the following:

a. An issue of national priority

b. A setting of environmental interest

c. Topic/process oriented content

d. A contextual map

A MAJOR GOAL OF ENVIRONMENTAL EDUCATION IS TO DEVELOP IN LEARNERS AN AWARENESS AND BROAD UNDERSTANDING OF ISSUES OF NATIONAL PRIORITY

a. An issue of national priority represents a major environmental issue or problem which is or should be of concern to our national, state, and local leaders...and to citizens in general. Such an issue is broad in impact and complex in nature. Resolution of the issue involves an ongoing process of making and changing policies, regulations, and legislation, and of altering personal values and lifestyles.

In general, an environmental, energy-focused issue of national priority arises from what might be called the "new scarcity" which reflects our approaching the finite planetary limits of: fossil fuels and strategic minerals; natural fresh water; food-productive, arable land; habitable surface area; waste-absorptive capacity of the natural environment; and resilience of the planet's life-support ecosystems.

Examples of issues of national priority which address these "new scarcity" areas are:

- energy resource delivery and use
- energy conserving resource utilization
- optimal use of finite land resources
- energy-intensive urban growth and the quality of life

A MAJOR CONCERN OF ENVIRONMENTAL EDUCATION IS TO DEVELOP IN LEARNERS AN UNDERSTANDING OF ISSUES OF NATIONAL PRIORITY AS THEY OCCUR IN A VARIETY OF SETTINGS.

b. A setting of environmental interest provides a milieu or frame of reference for focusing on and setting boundaries for the study of an environmental or energy issue of national priority. This setting can be specified in a variety of ways according to:

(1) Natural systems boundaries

- Aquasphere (oceans, lakes, rivers, streams, marshes, aquifers, etc.)
- Lithosphere (mountains, plains, forests, woodlands, deserts, etc.)
- Atmosphere (rainfall, winds, temperatures, sunlight, etc.)

(2) Human systems boundaries[1]

- Shelters (housing, community facilities, city centers)
- Networks (public utility systems, transportation systems, communication systems)
- Individual (physiological needs, safety and security, affection, belonging, esteem, self-actualization, knowledge, aesthetics)
- Society (government systems, legal systems, economic systems, political systems, cultural patterns, population trends, health and welfare systems)

(3) Geographical-political boundaries

- Local, county level of focus
- Multi-county, state level of focus

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[1] Adapted from Ekistics, Vol. 41, No. 246, May, 1976, pp. 257-262.

- Multi-state, regional level of focus
- National level of focus
- International, global level of focus

An example of an issue of national priority specified in terms of a setting of environmental interest is: the impact of proposed coal mining operations on a Tri-County Region (geographical-political setting).

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c. Topic and process areas provide important focus points for selecting and organizing learning resources to study environmental and energy issues of national priority within specific settings.

> A CENTRAL CONCERN OF ENVIRONMENTAL EDUCATION IS TO DEVELOP IN LEARNERS AN UNDERSTANDING OF THE IMPACTS AND INTERRELATIONSHIPS OF VARIOUS TOPIC AREAS AS THEY ADDRESS ISSUES OF NATIONAL PRIORITY OCCURING IN SPECIFIC SETTINGS.

(1) Key topics provide the learner with a variety of convenient areas[1] for studying an environmental/energy issue of national priority. These areas are so interrelated with respect to environmental issues in general that an entry investigation of one area leads, in most cases, to an investigation of the others as well.

The key topic areas include:

TOPIC ORIENTED

- Population dynamics
- Pollution
- Resource allocation and depletion
- Conservation
- Transportation
- Technology
- Urban and rural planning
- Environmental quality
- Ecological balance
- Natural resource related careers and vocations
- Economic and technological development
- Environmental ethics

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[1] All but the last three of these have been designated by the Environmental Education Act, Public Law 91-516 (as amended by P. L. 93-278) as areas of major importance in environmental education. The last three have been added by the developers of this module.

A MAJOR CONCERN OF ENVIRONMENTAL EDUCATION IS TO DEVELOP IN LEARNERS AN UNDERSTANDING OF AND FACILITY IN APPLYING PROCESSES IN STUDYING ISSUES OF NATIONAL PRIORITY WITHIN SPECIFIED SETTINGS.

(2) Key processes provide the learner with useful conceptual and analytic entry points for studying any issue of national priority in any setting. These processes do not conflict with, but instead complement, the topic oriented entry points specified previously.

The key processes include:

PROCESS ORIENTED

- Analytical or conceptual tools for understanding energy and environmental systems
- Problem-solving and decision-making strategies
- Holistic lifestyle assessment
- Fundamental concepts and principles of energy (energetics)
- Energy delivery systems and processes
- Forecasting, planning, and policy formation
- Futures thinking

Examples of topic and process oriented content which might be studied in the example situation of investigating the impact of coal mining on the Tri-County Region (setting) are:

TOPIC ORIENTED CONTENT

Projected population growth and increased demands for resources (population dynamics, resource allocation and depletion)

Increased pollution and long term environmental health problems (pollution, environmental quality)

PROCESS ORIENTED CONTENT

Carrying capacity analysis as a basic for decision-making (problem-solving and decision-making strategies)

Net energy costs and benefits involved in coal mining operations (energy delivery systems and processes).

YOU SHOULD NOW BE FAMILIAR WITH THE BASIC CHARACTERISTICS OF AN ENVIRONMENTAL, ENERGY-FOCUSED PROBLEM CONTEXT--SPECIFICALLY ADDRESSING:

- AN ISSUE OF NATIONAL PRIORITY
- IN A SETTING OF ENVIRONMENTAL INTEREST
- WITH TOPIC/PROCESS ORIENTED CONTENT

In the section which follows, the problem context becomes the basis for your planning an environmental energy-focused instructional unit(s) or lesson(s) for your students.

d. The Contextual Map

In order to identify the key topics, concepts and principles which constitute the "territory" of energy delivery's problems and issues, we have developed--as a design tool--the notion of a contextual map. This map shows not only the relevant topic areas, but also demonstrates the relationships of the content. It ensures that the problem area is presented in terms of both natural and human systems considerations as well as the interactions between the systems. This contextual map is useful as an organizational tool and a point of reference for teachers.

The contextual map organizes the module content into:

- content dealing primarily with NATURAL SYSTEMS:
- content dealing primarily with HUMAN SYSTEMS; and,
- content dealing with the INTERACTIONS between these two systems.

These major sectors are drawn as follows:

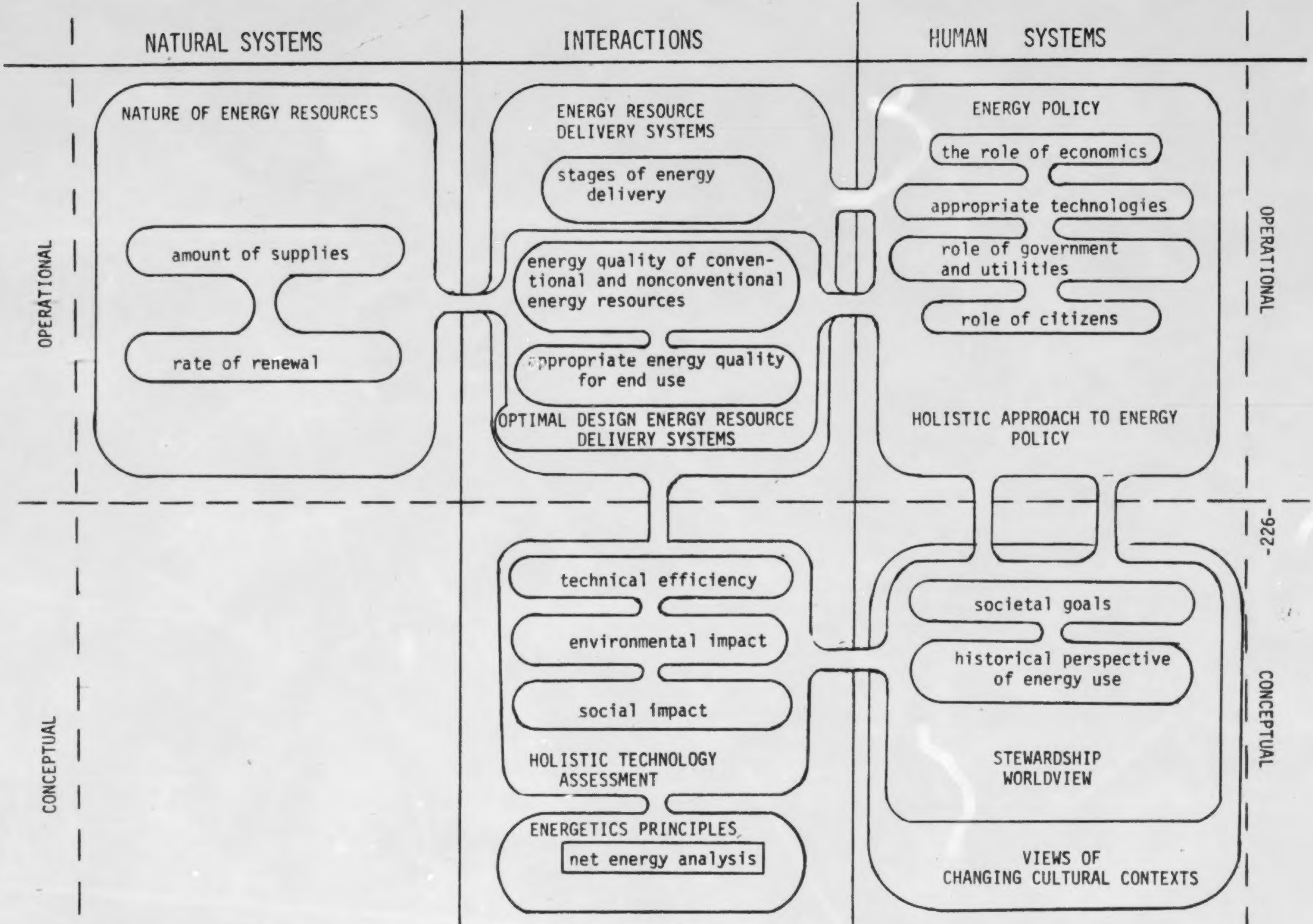
NATURAL SYSTEMS	INTERACTIONS	HUMAN SYSTEMS

The map further organizes the module content into:

- content dealing primarily with OPERATIONAL aspects (processes, functions, and applications of concepts); and
- content dealing primarily with CONCEPTUAL aspects (emphasizing ideas, theories, principles and laws)

	NATURAL SYSTEMS	INTERACTIONS	HUMAN SYSTEMS	
OPERATIONAL				OPERATIONAL
CONCEPTUAL				CONCEPTUAL

This Contextual Map organizes some important concepts in the environmental problem area of Energy Resource Delivery and Use. The map helps us visualize some of the possible interactions between human and natural systems that drive the energy resource delivery system. By looking at the Contextual Map, we can summarize these interactions.


NATURAL SYSTEMS
INTERACTIONS
HUMAN SYSTEMS
OPERATIONAL
CONCEPTUAL
NATURE OF ENERGY RESOURCES
amount of supplies
rate of renewal
ENERGY RESOURCE DELIVERY SYSTEMS
stages of energy delivery
energy quality of conventional and nonconventional energy resources
appropriate energy quality for end use
OPTIMAL DESIGN ENERGY RESOURCE DELIVERY SYSTEMS
ENERGY POLICY
the role of economics
appropriate technologies
role of government and utilities
role of citizens
HOLISTIC APPROACH TO ENERGY POLICY
technical efficiency
environmental impact
social impact
HOLISTIC TECHNOLOGY ASSESSMENT
ENERGETICS PRINCIPLES
net energy analysis
societal goals
historical perspective of energy use
STEWARDSHIP WORLDVIEW
VIEWS OF CHANGING CULTURAL CONTEXTS
OPERATIONAL
CONCEPTUAL

CONTEXTUAL MAP: ENERGY RESOURCE DELIVERY AND USE

CONTEXTUAL MAP: ENERGY RESOURCE DELIVERY AND USE

The satisfaction of human needs through the utilization of natural resources is an interactive process. This Contextual Map indicates these connections between natural and human systems.

NATURAL SYSTEMS CONCEPTUAL: You will note that this sector is blank on the map. This is because the nature of energy delivery is basically Human Systems and Interactions oriented.

NATURAL SYSTEMS OPERATIONAL: It is the nature of energy resources, particularly their amount of supply or rate of renewal, which determines the renewability or nonrenewability of an energy resource, and is one determinant of an optimal design of an energy delivery system.

INTERACTIONS OPERATIONAL: The connection between the nature of energy resources and optimal design of energy resource delivery systems is indicated above. The other major factors influencing the complexity and length of a delivery system are the energy quality of the original resource and how appropriate the energy quality is for end use.

HUMAN SYSTEMS CONCEPTUAL: In order to understand how we developed our dependence on certain energy delivery systems, and how we can alter our ways of thinking about energy resource availability, delivery, and consumption, we can look at views of changing cultural contexts, past and present. To do this, we can focus on the emerging stewardship worldview, as a conceptual basis for evaluating energy delivery and formulating a comprehensive energy policy.

INTERACTIONS CONCEPTUAL: The holistic stewardship worldview provides the perspective necessary to evaluate an energy resource delivery system. To create a tool that reflects this holistic perspective, we can establish a framework for holistic technology assessment, which includes coverage of the technical efficiency, environmental impacts, and societal impacts of an energy delivery system.

HUMAN SYSTEMS OPERATIONAL: The stewardship worldview also contributes to the way we formulate energy policy. From this perspective, we can examine the conflicts and constraints found in the current energy policy making process, and arrive at a framework from a holistic approach to energy policy making. This approach is based on four components: the role of economics, the notion of appropriate technologies, the role of government and utilities, and the role of environmentally aware citizens. A holistic approach to energy policy making considers the optimal design of energy delivery systems from a stewardship point of view.

OBJECTIVE: (k) To list the major topics, concepts, principles and processes associated with an environmental energy problem and display them in a contextual map.

TO DO:

1. Examine the contextual map (Figure A, p.226). Note that the map displays the major topics, concepts, principles, and processes associated with the environmental issues of Energy Resource Delivery and Use.
2. Using the general environmental issue of energy delivery, select a specific delivery system and its problems to present to your students. Think about its problems in terms of:
   - (a) aspects involving natural systems, human systems, and the interactions between the two systems;
   - (b) major topics, concepts, principles, and processes associated with these aspects.
3. List at least 20 major topics, concepts, principles, and processes associated with your energy delivery problem. Clarify and display these topics, etc. using the contextual map format below:

NATURAL SYSTEMS	INTERACTIONS	HUMAN SYSTEMS

SECTION 2

CHECKLIST FOR PLANNING ENVIRONMENTAL/ ENERGY-FOCUSED INSTRUCTIONAL UNITS OR LESSONS

After completing this section you should:

(8) Be able to plan instructional activities for your students by applying a set of guideline criteria.

This section presents guideline questions for planning and developing environmental/problem-focused instructional materials and activities.

CHECKLIST FOR PLANNING ENVIRONMENTAL/ENERGY-FOCUSED INSTRUCTIONAL UNITS OR LESSONS

Having completed the preceding design activity, you are now ready to develop a tentative plan for a "resource delivery" unit or lesson which is compatible with, but not necessarily limited to your subject area, e.g., Social Sciences, Natural Sciences, Humanities, etc. You can develop this plan by using the checklist which follows.

This checklist consists of a series of questions you should address when planning environmental/ energy-focused instructional activities for your students. Successful completion of these questions will help to ensure your developing an effective and instructionally sound unit or lesson plan.

Since the checklist questions are intended only as a guide for your planning task, you are free to address them in any of the following ways:

- you can plan a problem-focused instructional unit or lesson according to your own interests and planning style, and then refer back to the checklist to ensure that your plan is comprehensive.
- you can plan an instructional unit or lesson by answering the checklist questions directly as listed or in any order you choose.
- You can plan an instructional unit or lesson by utilizing both of these approaches, i.e., alternating between the two as your plan develops.

Whichever of these approaches you intend to use, it is strongly recommended that you begin your planning by considering the problem context of the unit or lesson (addressed in checklist question #1) which will be the basis for your entire plan.[1]

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[1] Prior to making your plan you may also want to read Appendix A, Planning Instructional Unit or Lessons, for a review of some characteristics of classroom instructional materials, and Appendix B, Developing an Instructional Unit or Lesson Following the Module Format.

CHECK COMPLETED
PLANNING AREAS
HERE
⬇

a. Have you selected an environmental/energy problem context appropriate for your students?

(1) Have you selected a problem area or issue of national priority or significance? ☐

What is your problem area or issue?

(2) Have you determined the level at which your problem has significance? ☐

- local, county ________
- multi-county, state ________
- multi-state, regional ________
- national ________
- international, global ________

Keep in mind that the most important environmental/energy problems have implications or counterparts at all or many of these levels.

(3) Have you characterized the major focus or emphasis of your unit or lesson? (You may prefer to answer Questions d. and e. before completing your answer here). ☐

- Natural systems functions, processes ________
- Human systems functions, processes ________
- Interactions between natural and human systems ________

Keep in mind that a HOLISTIC and INTEGRATED approach to studying the problem area would involve an examination or exploration of the complex interrelationships between natural and human systems rather than focusing exclusively on either.

(4) Have you characterized the various aspects of the problem area which your students are to investigate? (You may prefer to answer Questions d. and e. before completing your answer here). ☐

- physical ________
- social (includes economic, political, legal, etc.) ________
- aesthetic ________
- ethical ________

Keep in mind that a TRANSDISCIPLINARY approach to studying the problem area would involve an examination and synthesis of information from a variety of aspects, disciplines, or points of view.

b. Have you considered how you will introduce the problem issue to your students; how you will interest and motivate them? ☐

Pep talk ____ Movie ____ Guest Speaker ____

Field trip or site visit ____

Student self-directed activity ____

Other ________________________________

c. Have you determined what broad or general questions regarding the problem area you want your students to answer or address? ☐

What are these general questions?

d. Have you identified key topics or sub-topics related to the problem area which your students will cover? ☐

What are these key topics or sub-topics?

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e. Have you identified key concepts, principles, and terminology which will be covered? ☐

What are these key concepts, principles, ideas, and terminology?

f. Have you determined whether or not there are special knowledge or skill prerequisites that your students should have in order to study the problem area? ☐

What are these prerequisites?

g. Have you decided what learning activities you are planning to use to convey the relevant topics, concepts, principles, etc. to your students? (Example activities might include: tours, field trips, written assignments, lectures, interviews, experiments, special projects, simulations, discussions, etc.). ☐

What are these activities? (Be as specific as possible.)

(You may prefer to answer Question #1 below before completing your answer here.)

(1) Do any of the activities engage your students in PROBLEM-SOLVING or DECISION-MAKING processes with respect to the problem area? ______

(2) Are the activities ones that your students can:

- relate to in terms of their experiences? ______
- complete in the amount of time available? ______

h. Have you identified available resources which your students will need in studying the problem or issue? (Resources might include: readings, films, interviews, reports, etc.) ☐

What are these resources? (Be as specific as possible.)

i. Have you specified student learning objectives for the unit or lesson? ☐

What are these student learning objectives?

j. Have you determined how you will evaluate whether or not your students have achieved these learning objectives? (Evaluative measures might include: discussion questions, written or oral reports, special task or project assignments, test questions, etc.) ☐

What are these evaluative measures? (Be as specific as possible.)

k. Have you determined an instructional sequence and schedule for your unit or lesson? ☐

Describe the sequence of activities in as much detail as possible, i.e., describe your lesson plan.

EXAMPLE FORMAT:

Day/ week	Topics/sub-topics to be covered	Key concepts, principles, ideas to be covered	Activities to be used to convey the topics & key concepts

OBJECTIVE: (1) To complete a checklist for planning environmental instructional units or lessons

TO DO: 1. Now that you are familiar with the characteristics of a problem context and have read over the guidelines for developing an instructional unit or lesson, you can begin the process of planning your own instructional unit, lesson, or program. Remember that your ultimate planning goals are:

- To engage students in learning activities (readings, discussions, exercises, etc.) which address environmental issues or problems, e.g., ENERGY RESOURCE DELIVERY AND USE.
- To raise students' level of awareness and understanding of the issues or problems to a level as near as possible to your own.

2. Start by filling out each of the CHECKLIST items (p. 231) as best you can. Keep in mind that these items are intended to aid you in being as detailed and specific as possible in planning your classroom environmental unit(s) or lesson(s).

3. Feel free to utilize the CHECKLIST in any way you deem helpful. For example, you may decide to: (1) develop an instructional unit or lesson plan on your own, then use the CHECKLIST items to assess the scope and adequacy of your plan; or (2) complete the CHECKLIST first, then reorganize and sequence the information into an instructional plan.

Once you have completed the APPLICATION, you should:

- BE FAMILIAR WITH THE BASIC CHARACTERISTICS OF AN ENVIRONMENTAL/ENERGY PROBLEM OR ISSUE CONTEXT.
- HAVE DEVELOPED A PRELIMINARY PLAN FOR AN ISSUE OR PROBLEM-FOCUSED ENVIRONMENTAL UNIT(S) or LESSON(S) (e.g., ENERGY-RESOURCE DELIVERY AND USE) which can be implemented in your classroom.

APPENDICES

APPENDIX A: PLANNING INSTRUCTIONAL UNITS OR LESSONS

APPENDIX B: DEVELOPING AN INSTRUCTIONAL UNIT OR LESSON FOLLOWING THE MODULE FORMAT

APPENDIX C: INQUIRY ACTIVITY ANSWERS

PLANNING INSTRUCTIONAL UNITS OR LESSONS

A. DISTINCTION BETWEEN A SINGLE CONCEPT AND A MULTIPLE CONCEPT APPROACH

Question--How does a single concept approach to environmental education differ from a multiple concept approach?

A single concept approach has these characteristics:

- a single concept or skill is treated;
- instructional content is brief, requiring only a few days to complete;
- only a few, highly specific resources are used.

A multiple concept approach has these characteristics:

- several concepts or skills are treated;
- instructional content is longer, containing several concepts, and may take several weeks to complete;
- many resources, both general and specific, are used.

Question--When should you emphasize a single or multiple concept approach?

The single concept approach should be emphasized:

- when you are dealing with a single, discrete idea or topic area--not a cluster of ideas or skills, or a problem area or theme;
- when your intent is to introduce the learner to a set or series of single concepts, ideas, or skills as preparation for presenting a more complex problem context;
- when an understanding of the overall problem area or context is not, for the moment, of primary importance.

The multiple concept approach should be emphasized:

- when you are dealing with a set of environmental concepts, ideas, or skills which are complex;
- when your intent is to involve students in planning or decision-making on a group or team basis;
- when it is important to present an entire problem context, e.g., the natural, social (including political, economic, legal), aesthetic, and ethical aspects of the selected issue as a necessary background to planning and decision-making;
- when in-depth inquiry and value-development are part of the planning and decision-making application.

These criteria are not hard and fast, but they suggest two instructional possibilities: (a) younger students might benefit more from a single concept approach in order to prepare or ready them for involvement in more complex activities; and (b) a multiple concept approach might better serve secondary school students (grades 10-12) and adults. Intermediate level students, grades 7-9, may benefit from a combination of both approaches.

In the APPLICATION, we emphasize the design of instructional units or lessons which utilize a multiple concept approach in addressing environmental issues of national importance.

B. CHARACTERISTICS OF INSTRUCTIONAL UNITS OR LESSONS

In planning environmental education instructional units or lessons, consider the following self-directing questions. As you address these questions in your initial planning, you should begin to form a general picture of the features or characteristics of your instructional units or lessons.

1. Student factors

THINGS YOU NEED TO KNOW AHEAD OF TIME

- What is your understanding of your students' degree of preparation or readiness for problem-focused, decision-making oriented learning materials and experiences?
- Is the problem area too sophisticated or complex?
- Are the reading resources (such as those presented in the bibliography of this module) too difficult, too sophisticated?
- Would learning exercises or simulation activities (such as those presented in the INQUIRY) be too difficult, too demanding?
- Would your students be able to work effectively within a group or team learning mode? Will it be necessary to utilize a more individualized learning approach? Some combination of group and individualized learning?

If you are uncertain as to your students' readiness or motivation for these activities, you may wish to assess their preparation with some preliminary learning activities involving:

WAYS YOU CAN FIND OUT

- sample readings addressing the problem context with follow-up class discussions (these may focus on single concepts or single subtopics as expedient);
- small group assignments to explore some specific community resources related to the problem context (e.g., tours, site visits, talks with knowledgeable persons, etc.);
- simplified problem-solving, decision-making, or values clarification exercises focusing on some sub-aspect of the problem issue.

Remember that in assessing your students' readiness, it is not so important to determine how much they know about the problem issue as it is to determine if they will be able to: (a) complete reading and resource exploration assignments, (b) interact and exchange ideas effectively in large or small groups, and (c) utilize problem-solving and decision-making processes required in the learning activities (exercises, simulations, etc.).

2. Teacher factors

- Do you see yourself only, you and another teacher, another teacher only, or a larger teacher team using the instructional materials?
- How much direction, guidelines, or preparatory training will this person or persons require?

WHO WILL USE THE MATERIALS

If you see yourself as the prime or sole user of the instructional materials, you will still need to specify the details of an instructional plan. The specific learning activities and the schedule of events should be specified.

If you are devising the instructional materials for other persons, then very detailed usage steps, timetables, and resource materials will need to be provided in addition to the above.

And with team-devised/team-taught materials, it is suggested that a set of directions be provided so that one person can serve as a team monitor to keep track of instructional variations, new ideas, and changes in procedures, and to monitor and record the entire set of activities.

3. Instructional factors

- What should go into the instructional plans for developing the environmental education units or lessons?

Here are a minimum number of things to consider:

a. Instructional aims--the overall educational reasons or benefits for using the materials.

b. Learning objectives--the general and specific knowledge and skill development objectives, stated in behavioral terms, that is, in terms which are measurable and observable and which specify criteria against which successful performance can be assessed. With student-training materials, the learning objectives should be keyed directly to the steps of the instructional sequence.

c. Resource requirements--the required and optional learning resources for developing students' knowledge and skills. The resources might include films, slides, and other A-V materials, maps, charts, case studies, bibliographies, monographs, periodicals, newspapers, magazine articles, textbooks, paperbacks, tours, lectures, T.V. and radio programs, site visits, agency/organization publications, interviews, field studies, learning games, simulations. These resources can be teacher-prepared, student-devised, or commercially prepared.

d. Learning arrangements--as a rule, student learning arrangements should vary or change during the instructional sequence of units or lessons. Thus, students move through a series of large group, small group, and individual study/discussion/application tasks as required by the instructional sequence. This practice offers the student not merely a "change of pace," but opportunities for escaping either psychologically or physically from the confines of standard classroom pedagogy.

e. Timetables, schedules--multiple-concept, problem-focused instructional units, especially when preceded by shorter, single-concept preparation units, may take several weeks to complete. It is important that time allocations, sequences, and schedules for instructional/learning activities be specified.

f. Information handling and evaluation--within a given unit or lesson, there are a number of useful student evaluation checks which can be built into each step of the instructional sequence, e.g., student reports, discussion worksheets, inquiry and application task checklists, and other evaluative materials. It is necessary, therefore, to indicate the procedures to be used and the forms to be collected at the end of each step. It is also necessary to key the evaluation to the student learning objectives.

g. Options and special activities--there can be many resources and activity options at each step of an instructional sequence. This flexibility should be utilized by teachers to ensure that the learning activities are compatible with the needs, interests, and abilities of students. Therefore, if desired, optional or special learning resources (and activities) can be used.

4. Instructional sequence

- What general steps or tasks need to be specified for an instructional unit or lesson which develops students' knowledge and skills in a selected environmental problem issue?

The instructional sequence or steps can follow any one of a number of formats depending on the intended users. The general format utilized in the present instructional module and a student-oriented variation of it are presented in Table One only as examples:

TABLE ONE

The teacher training module instructional sequence	A possible student lesson instructional sequence
• INQUIRY	• INQUIRY
Knowledge development (utilize problem-relevant resource materials)	Knowledge development (utilize problem-relevant resource materials)
• INTEGRATION	• INTEGRATION
Skill development (utilize problem-focused exercises, simulations)	Skill development (utilize problem context-focused exercises, simulations)
• APPLICATION	• APPLICATION?
Student learning unit/ lesson design and development	

5. Problem context

- What tasks are necessary to develop the environmental problem context described in Section 1 of the APPLICATION?

In order to develop this problem context to a level which is presentable to students, you will need to do the following:

a. Identify a problem issue which has both national significance and significance at regional, state, or local levels.

b. Select (or develop if necessary) a regional, state, or local level scenario as a frame of reference for studying the problem issue--whichever level is of greater interest or significance to learners.

c. Identify available resources (readings, tours, lectures, films, interviews, etc.) for studying the problem issue at the level (or levels) selected.

When properly developed, the problem context will constitute an effective and comprehensive basis for exploring the environmental problem issue through case studies, simulations, and other learning activities.

DEVELOPING AN INSTRUCTIONAL UNIT OR LESSON FOLLOWING THE MODULE FORMAT

The student instructional sequence presented in Appendix A, Table One will now be utilized to present some basic tasks necessary for developing an environmental/energy-focused instructional unit or lesson similar in format to the one utilized in this teacher-training module. These tasks, when fully elaborated and geared to the students' level of sophistication, can take the form of a user-ready set of student learning materials or a set of instructional guidelines for making topic presentations, problem-focused classroom discussions, student work assignments and skill development exercises, and evaluating students' performance and progress.

Keep in mind that this is an example of only one possible instructional unit or lesson format for your students. If you wish to utilize another format, proceed according to the guideline questions of Section B of the APPLICATION.

STEP ONE: INQUIRY--Develops students' knowledge base regarding the selected environmental problem issue by involving them in an in-depth exploration of the problem--using relevant learning resources.

1. Describe the environmental problem or issue for the unit or lesson. Tell students why this problem is significant nationally, locally, regionally, or globally as the case may be. Tell them why you have selected this problem area from other possible ones.

2. Describe the instructional sequence for the unit or lesson, the instructional strategies you will use, and the learning arrangements they will use. Explain the general learning (knowledge and skill) objectives, the general time-line or schedule of events, the resource requirements, and the criteria and methods by which they will be evaluated (or will evaluate themselves).

3. Define all terms which students don't understand.

4. Define or describe the essential questions which must be answered regarding the problem (or have the students do this if they select the problem area). Make certain the problem issue has been adequately specified by defining or describing relevant data resources, concepts, principles, and activities related to the problem area.

5. Organize the resources in several ways to diversify students' possible entries into the knowledge base: (a) organize them according to natural systems, human systems, or the interactions between the two; (b) organize them according to topics (key environmental entities) or process (content/processes) you wish to emphasize; (c) organize them according to the various physical, social (including economic, political, legal), aesthetic, and ethical aspects of the environmental/energy problem issue.

   Teachers can begin the process of selecting and organizing student learning resources by asking themselves (a) which of the topics, sub-topics associated with the subject area, and (b) which learning resources are relevant to both the problem area and to my own subject area.

6. Develop a list of study/discussion questions to guide students in their exploration of the learning resources. Key these questions to the major features or critical points of the environmental/energy problem issue covered by the resources. Use these questions in written assignments or follow-up discussions to assess students' depth of understanding.

STEP TWO: INTEGRATION-- Develops students' skills in applying their knowledge of the environmental problem issue by involving them in policy planning and decision-making activities.

For example, a simulation activity would require you to:

1. Select or prepare a general scenario which describes the environmental problem in a specific setting (local, regional, national, global).

2. Prepare a set of descriptions or guidelines for the students to act as planners, policy-makers, and decision-makers in addressing the problem issue presented in the scenario. Organize students into groups or subcommittees and assign each to explore a different major aspect of the problem in more depth.

3. In order to heighten students' interest in the activity, you may wish to enhance the problem scenario by preparing a set of descriptions or representative articles or documents (e.g., letters of concern) which present the viewpoints and concerns of individuals and groups who might reasonably be affected by or interested in the problem issue. It may be useful to key these concerns to the major physical, social, aesthetic, and ethical aspects of the problem context.

4. Select or prepare a set of data or facts which cover the energy aspects of the problem scenario and which the students can use in their planning, problem-solving, or decision-making task. Prepare any additional information, maps, charts, illustration, etc., which the students may need.

5. Develop a general time-table or schedule for how long each task of the simulation is to last and the order in which tasks are to be carried out.

6. Define all terms and concepts which students don't understand. Clarify any misunderstanding regarding the major aspects of the problem issue, use of resources, or simulation procedures. Hold a post-simulation debriefing with students to summarize their findings, conclusions, and recommendations.

STEP THREE: EVALUATION--Evaluation items may be developed for each step or for the entire unit or lesson.

- INQUIRY evaluation should assess students' overall understanding of the key dimensions or critical aspects of the environmental problem context.

> Key question--Have students acquired the requisite knowledge and level of understanding of the environmental problem?

- INTEGRATION evaluation should assess students' general performance in developing coherent positions or in formulating justifiable policy statements regarding the problem issue.

> Key question--Are students able to utilize their knowledge and understanding in a problem-solving or decision-making task?

Keep in mind that evaluation measures may take one or several of the following forms:

Think/discussion questions

Written and oral reports

Performance assessment of activities, tasks, or special project assignments

Test questions

INQUIRY
ACTIVITY
ANSWERS

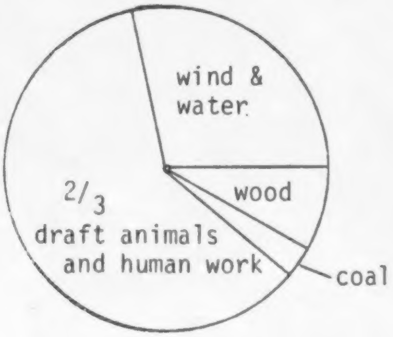
Appendix C provides example answers to each of the Activities in the INQUIRY. Many of these answers have been devised by teachers and are offered as a basis for comparison only.

SECTION 1

ACTIVITY I

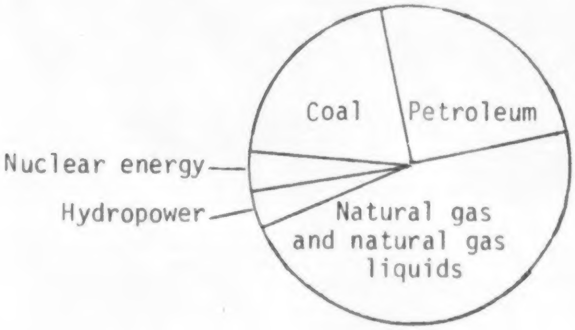
1. Hunting and gathering society: wood for fire, solar energy.
   Agrarian society: fire, photosynthesis, water
   Advanced agrarian/pre-industrial society: wind, water power, wood, coal, charcoal
   Industrial society: steam, water, wind, wood, coal, oil

2. U.S. ENERGY CONSUMPTION 1850 (Steinhart, p. 36)



3. Creation of vast private fortunes,
   new waves of immigration providing abundant labor,
   development of marketing techniques and the market system,
   expanding network of railroads,
   innumerable inventions,
   substitution of mass production techniques for craft.

4. U.S. ENERGY CONSUMPTION 1970 (Scientific American, pp. 86-87).



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SECTION 1 (Cont'd.)

ACTIVITY II

Following is an example Worldview Characterizations Chart (#1) to give you an idea of how these will look:

Stewardship Worldview Valve	Reading: Henderson, Creating Alternative Futures (Title, Author) Exemplary Statements
(1) "Spaceship earth" thinking	We need to assess the ideologies, paradigms and myths which ...reflect that which is eternal in the human condition, in our continually evolving interaction with our ecosystem... p. 11
(2) "Alternatives futures" thinking	(All this is) leading to spontaneous efforts to create alternative futures and decentralize our society and its technological means. p. 24
(3) "Problems of success"	The paradox of greater micro-efficiency of production, but less social efficiency and individual consumer efficiency, is now leading to widespread social alienation.p. 31
(4) Humanistic and spiritual values	We see heroic efforts to reintegrate perceptions in the struggle to create more holistic research methods and models. p. 17
(5) Awareness of inequities	Citizen movements...constitute vital feedback to our body politic... because they spontaneously organize around all of the dis-economies, dis-services, and dis-amenities which such policies create as unanticipated, second-order consequences. p. 21
(6) Social roles and automation	Demands for worker control and self-management are growing. p. 24
(7) Increased interest in spiritual concerns	The new explorations of power of the human mind are a survival tool to help us project ourselves out of modes of thinking and being that are now evolutionarily blocked. p. 25

SECTION 2

ACTIVITY: One example is provided in the exercise (p. 73).

SECTION 3

ACTIVITY: One example is provided in the exercise (p. 107).

SECTION 4

ACTIVITY I:

1. One example is provided in the exercise (p. 135).
2. Discussion should include the relationship between government and the energy industry and how API addresses this relationship through policy recommendations; also the economic incentives recommended by API, their relationship to consumer costs; synthetic fuels and nonconventional resources; environmental protection.
3. Discussion should include how API, as a representative industry organization, would affect the long-standing policy directions, particularly exponential growth, national security and supply protection, and the "technicist" syndrome.
4. Discussion should include industry-economic growth relationships, fuel demand and consumption, electricity supply and demand, the inequities of foreign energy distribution, and the power of oil-producing nations.

ACTIVITY II

1. One example is provided in the exercise.
2. Discussion should include how the Texas energy policy reflects changing attitudes with regard to current policy directions.
3. One example is provided in the exercise.

SECTION 5

ACTIVITY I:

1. - technology assessment should develop as a "value-free" scientific discipline; wholes can be understood by examining their parts; analysis favored over synthesis; reliance on "objectivity," quantification.

   - technology assessment is a process rooted in and responsive to changing societal values; value assumptions influence the choice of phenomena to be studied; the act of observation can change the object under examination; policies must include the dynamic role of human values, intuition, imagination, and art.

2. Discussion should include the development of public interest advocacy groups as a reaction to the interrelations between technologies and institutions; diseconomies, disservices, and disamenities of industrialized society; political influence of citizens in terms of changing values; technology assessment as "invented by" or constructed in response to citizens groups' concerns over environmental issues, energy supplies, and quality of life.

ACTIVITY II:

An example assessment is provided in the exercise.

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